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4th Edition

Early Release

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CSS

The Definitive Guide

VISUAL PRESENTATION FOR THE WEB

Eric Meyer & Estelle Weyl

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# CSS: The Definitive Guide

4th Edition

Eric A. Meyer

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by Eric A. Meyer

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Printed in the United States of America.

Published by O'Reilly Media, Inc. , 1005 Gravenstein Highway North,  
Sebastopol, CA 95472.

O'Reilly books may be purchased for educational, business, or sales promotional use. Online editions are also available for most titles ( <http://safaribooksonline.com> ). For more information, contact our corporate/institutional sales department: 800-998-9938 or [corporate@oreilly.com](mailto:corporate@oreilly.com) .

- Editor: Meg Foley
- Production Editor: FILL IN PRODUCTION EDITOR
- Copyeditor: FILL IN COPYEDITOR
- Proofreader: FILL IN PROOFREADER
- Indexer: FILL IN INDEXER
- Interior Designer: David Futato
- Cover Designer: Karen Montgomery
- Illustrator: Rebecca Demarest
- June 2017: Fourth Edition

# Revision History for the Fourth Edition

- YYYY-MM-DD: First Release

See <http://oreilly.com/catalog/errata.csp?isbn=9781449393199> for release details.

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978-1-449-39319-9

[FILL IN]

# Chapter 1. Basic Visual Formatting

This book is all about the theoretical side of visual rendering in CSS. Why is it necessary to spend an entire book (however slim) on the theoretical underpinnings of visual rendering? The answer is that with a model as open and powerful as that contained within CSS, no book could hope to cover every possible way of combining properties and effects. You will obviously go on to discover new ways of using CSS. In the course of exploring CSS, you may encounter seemingly strange behaviors in user agents. With a thorough grasp of how the visual rendering model works in CSS, you'll be able to determine whether a behavior is a correct (if unexpected) consequence of the rendering engine CSS defines, or whether you've stumbled across a bug that needs to be reported.

# Basic Boxes

At its core, CSS assumes that every element generates one or more rectangular boxes, called *element boxes*. (Future versions of the specification may allow for nonrectangular boxes, and indeed there are proposals to change this, but for now everything is rectangular.) Each element box has a *content area* at its center. This content area is surrounded by optional amounts of padding, borders, outlines, and margins. These areas are considered optional because they could all be set to a width of zero, effectively removing them from the element box. An example content area is shown in [Figure 1-1](#), along with the surrounding regions of padding, borders, and margins.

Each of the margins, borders, and the padding can be set using various side-specific properties, such as `margin-left` or `border-bottom`, as well as shorthand properties such as `padding`. The outline, if any, does not have side-specific properties. The content's background—a color or tiled image, for example—is applied within the padding by default. The margins are always transparent, allowing the background(s) of any parent element(s) to be visible. Padding cannot have a negative length, but margins can. We'll explore the effects of negative margins later on.

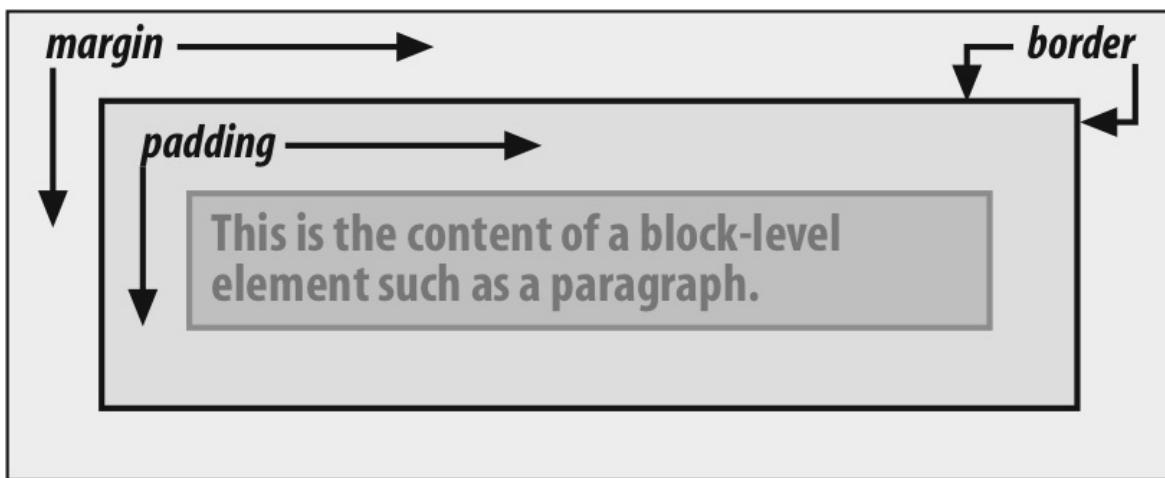


Figure 1-1. The content area and its surroundings

Borders are generated using defined styles, such as `solid` or `inset`, and their colors are set using the `border-color` property. If no color is set, then the border takes on the foreground color of the element's content. For example, if the text of a paragraph is white, then any borders around that paragraph will be white, *unless* the author explicitly declares a different border color. If a border style has gaps of some type, then the element's background is visible through those gaps by default. Finally, the width of a border can never be negative.

The various components of an element box can be affected via a number of properties, such as `width` or `border-right`. Many of these properties will be used in this book, even though they aren't defined here.

# A Quick Refresher

Let's quickly review the kinds of boxes we'll be discussing, as well as some important terms that are needed to follow the explanations to come:

## Normal flow

This is the left-to-right, top-to-bottom rendering of text in Western languages and the familiar text layout of traditional HTML documents. Note that the flow direction may be changed in non-Western languages. Most elements are in the normal flow, and the only way for an element to leave the normal flow is to be floated, positioned, or made into a flexible box or grid layout element. Remember, the discussions in this chapter cover only elements in the normal flow.

## Nonreplaced element

This is an element whose content is contained within the document. For example, a paragraph (`p`) is a nonreplaced element because its textual content is found within the element itself.

## Replaced element

This is an element that serves as a placeholder for something else. The classic example of a replaced element is the `img` element, which simply points to an image file that is inserted into the document's flow at the point where the `img` element itself is found. Most form elements are also replaced (e.g., `<input type="radio">`).

## Root element

This is the element at the top of the document tree. In HTML documents, this is the element `html`. In XML documents, it can be whatever the language permits; for example, the root element of RSS files is `rss`.

## Block box

This is a box that an element such as a paragraph, heading, or `div` generates. These boxes generate “new lines” both before and after their boxes when in the normal flow so that block boxes in the normal flow stack vertically, one after another. Any element can be made to generate a block box by declaring `display: block`.

## Inline box

This is a box that an element such as `strong` or `span` generates. These boxes do not generate “linebreaks” before or after themselves. Any element can be made to generate an inline box by declaring `display: inline`.

## Inline-block box

This is a box that is like a block box internally, but acts like an inline box externally. It acts similar to, but not quite the same as, a replaced element. Imagine picking up a `div` and sticking it into a line of text as if it were an inline image, and you’ve got the idea.

There are several other types of boxes, such as table-cell boxes, but they won’t be covered in this book for a variety of reasons—not the least of which is that their complexity demands a book of its own, and very few authors will actually wrestle with them on a regular basis.

# The Containing Block

There is one more kind of box that we need to examine in detail, and in this case enough detail that it merits its own section: the *containing block*.

Every element's box is laid out with respect to its containing block; in a very real way, the containing block is the “layout context” for a box. CSS defines a series of rules for determining a box’s containing block. We’ll cover only those rules that pertain to the concepts covered in this book in order to keep our focus.

For an element in the normal, Western-style flow of text, the containing block forms from the *content edge* of the nearest ancestor that generated a list item or block box, which includes all table-related boxes (e.g., those generated by table cells). Consider the following markup:

```
<body>
  <div>
    <p>This is a paragraph.</p>
  </div>
</body>
```

In this very simple markup, the containing block for the `p` element’s block box is the `div` element’s block box, as that is the closest ancestor element box that is a block or a list item (in this case, it’s a block box). Similarly, the `div`’s containing block is the `body`’s box. Thus, the layout of the `p` is dependent on the layout of the `div`, which is in turn dependent on the layout of the `body` element.

And above that, the layout of the `body` element is dependent on the layout of the `html` element, whose box creates what is called the *initial containing block*. It’s a little bit unique in that the viewport—the browser window in screen media, or the printable area of the page in print media—determines its dimensions, not the size of the content of the root element. It’s a subtle distinction, and usually not a very important one, but it does exist.

# Altering Element Display

You can affect the way a user agent displays by setting a value for the property `display`. Now that we've taken a close look at visual formatting, let's consider the `display` property and discuss two more of its values using concepts from earlier in the book.

## `display`

**Values:** none | inline | block | inline-block | list-item | run-in | table | inline-table | table-row-group | table-header-group | table-footer-group | table-row | table-column-group | table-column | table-cell | table-caption | inherit

**Initial value:** inline

**Applies to:** All elements

**Inherited:** No

**Computed value:** Varies for floated, positioned, and root elements (see CSS2.1, section 9.7); otherwise, as specified

We'll ignore the table-related values, since they're far too complex for this text, and we'll also ignore the value `list-item` since it's very similar to block boxes. We've spent quite some time discussing block and inline boxes, but let's spend a moment talking about how altering an element's display role

can alter layout before we look at `inline-block` and `run-in`.

# Changing Roles

When it comes to styling a document, it's obviously handy to be able to change the type of box an element generates. For example, suppose we have a series of links in a `nav` that we'd like to lay out as a vertical sidebar:

```
<nav>
  <a href="index.html">WidgetCo Home</a>
  <a href="products.html">Products</a>
  <a href="services.html">Services</a>
  <a href="fun.html">Widgety Fun!</a>
  <a href="support.html">Support</a>
  <a href="about.html" id="current">About Us</a>
  <a href="contact.html">Contact</a>
</nav>
```

We could put all the links into table cells, or wrap each one in its own `nav`—or we could just make them all block-level elements, like this:

```
nav a {display: block;}
```

This will make every `a` element within the navigation `nav` a block-level element. If we add on a few more styles, we could have a result like that shown in [Figure 1-2](#).



**Figure 1-2. Changing the display role from inline to block**

Changing display roles can be useful in cases where you want non-CSS

browsers to get the navigation links as inline elements but to lay out the same links as block-level elements. With the links as blocks, you can style them as you would `div` or `p` elements, with the advantage that the entire element box becomes part of the link. Thus, if a user’s mouse pointer hovers anywhere in the element box, she can then click the link.

You may also want to take elements and make them inline. Suppose we have an unordered list of names:

```
<ul id="rollcall">
  <li>Bob C.</li>
  <li>Marcio G.</li>
  <li>Eric M.</li>
  <li>Kat M.</li>
  <li>Tristan N.</li>
  <li>Arun R.</li>
  <li>Doron R.</li>
  <li>Susie W.</li>
</ul>
```

Given this markup, say we want to make the names into a series of inline names with vertical bars between them (and on each end of the list). The only way to do so is to change their display role. The following rules will have the effect shown in [Figure 1-3](#):

```
#rollcall li {display: inline; border-right: 1px solid; padding: 0 5px;}
#rollcall li:first-child {border-left: 1px solid;}
```

| Bob C. | Marcio G. | Eric M. | Kat M. | Tristan N. | Arun R. | Doron R. | Susie W. |

**Figure 1-3. Changing the display role from list-item to inline**

There are plenty of other ways to use display to your advantage in design. Be creative and see what you can invent!

Be careful to note, however, that you are changing the display role of elements—not changing their inherent nature. In other words, causing a paragraph to generate an inline box does *not* turn that paragraph into an inline element. In XHTML, for example, some elements are block while others are inline. (Still others are “flow” elements, but we’re ignoring them right now.)

An inline element can be a descendant of a block element, but the reverse is not true. Thus, while a `span` can be placed inside a paragraph, a `span` cannot be wrapped around a paragraph. This will hold true no matter how you style the elements in question. Consider the following markup:

```
<span style="display: block;">  
<p style="display: inline;">this is wrong!</p>  
</span>
```

The markup will not validate because the block element (`p`) is nested inside an inline element (`span`). The changing of display roles does nothing to change this. `display` has its name because it affects how the element is displayed, not because it changes what kind of element it is.

With that said, let's get into the details of different kinds of boxes: block boxes, inline boxes, inline-block boxes, list-item boxes, and run-in boxes.

# Block Boxes

Block boxes can behave in sometimes predictable, sometimes surprising ways. The handling of box placement along the horizontal and vertical axes can differ, for example. In order to fully understand how block boxes are handled, you must clearly understand a number of boundaries and areas. They are shown in detail in [Figure 1-4](#).

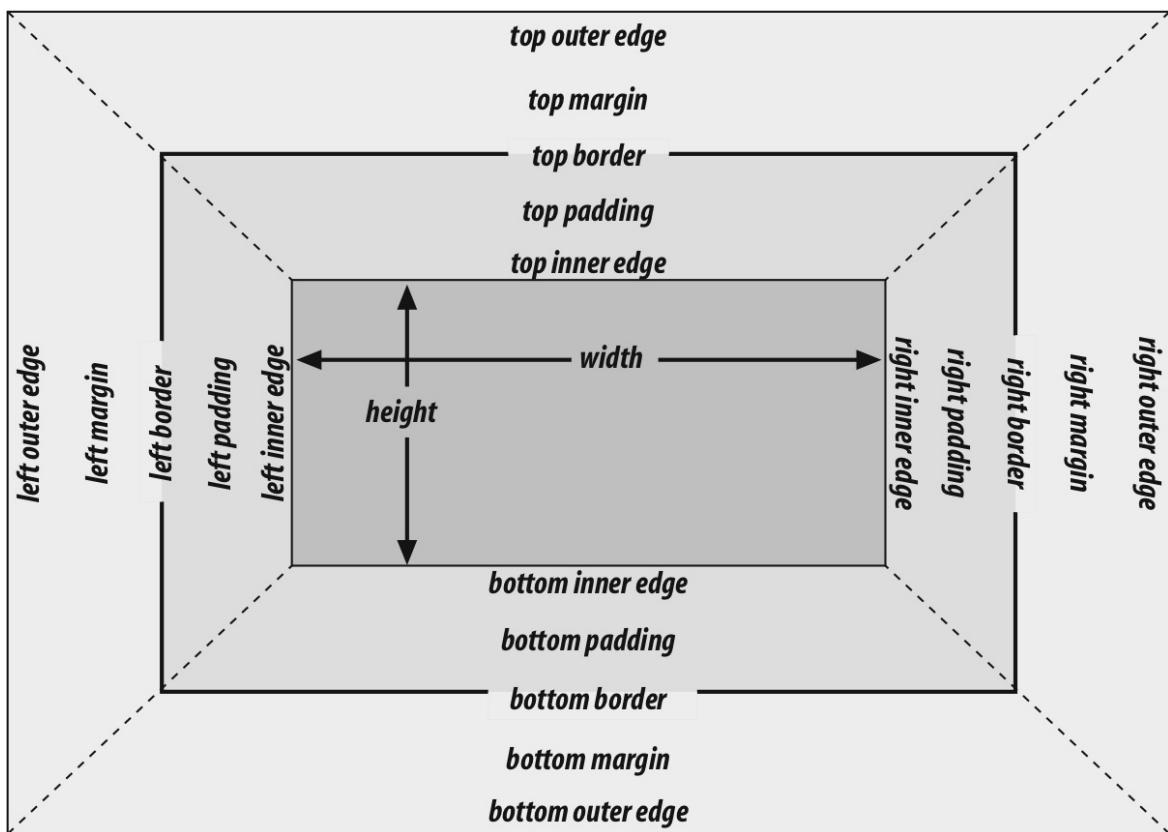


Figure 1-4. The complete box model

By default, the `width` of a block box is defined to be the distance from the left inner edge to the right inner edge, and the `height` is the distance from the inner top to the inner bottom. Both of these properties can be applied to an element generating a block box. It's also the case that we can alter how these properties are treated using the property `box-sizing`.

## box-sizing

**Values:** content-box | padding-box | border-box | inherit

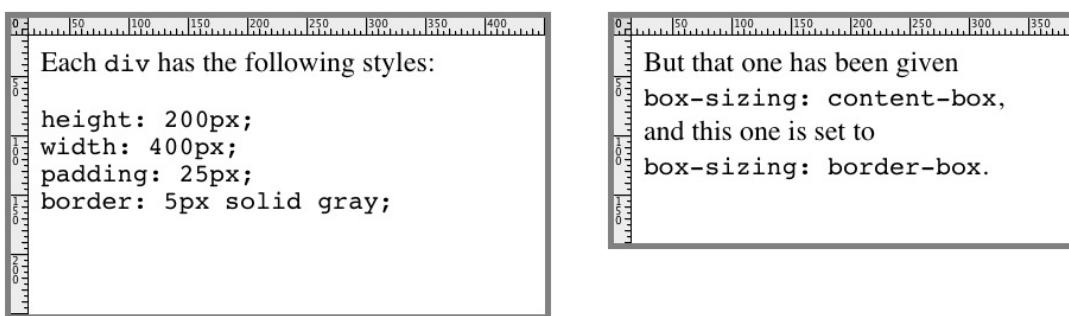
**Initial value:** content-box

**Applies to:** All elements that accept width or height values

**Inherited:** No

**Computed value:** As specified

This property is how you change what the width and height values actually do. If you declare width: 400px and don't declare a value for box-sizing, then the element's content box will be 400 pixels wide; any padding, borders, and so on will be added to it. If, on the other hand, you declare box-sizing: border-box, then it will be 400 pixels from the left outer border edge to the right outer border edge; any border or padding will be placed within that distance, thus shrinking the width of the content area. This is illustrated in [Figure 1-5](#).



**Figure 1-5.** The effects of box-sizing

We're talking about the `box-sizing` property here because, as stated, it applies to "all elements that accept `width` or `height` values." That's most often elements generating block boxes, though it also applies to replaced inline elements like images as well as inline-block boxes.

The various widths, heights, padding, and margins all combine to determine how a document is laid out. In most cases, the height and width of the document are automatically determined by the browser and are based on the available display region, plus other factors. With CSS, of course, you can assert more direct control over the way elements are sized and displayed.

# Horizontal Formatting

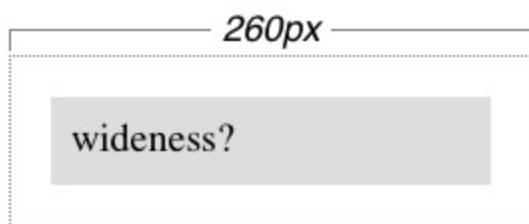
Horizontal formatting is often more complex than you'd think. Part of the complexity has to do with the default behavior of `box-sizing`. With the default value of `content-box`, the value given for `width` affects the width of the content area, *not* the entire visible element box. Consider the following example:

```
<p style="width: 200px;">wideness?</p>
```

This will make the paragraph's content 200 pixels wide. If we give the element a background, this will be quite obvious. However, any padding, borders, or margins you specify are *added* to the width value. Suppose we do this:

```
<p style="width: 200px; padding: 10px; margin: 20px;">wideness?</p>
```

The visible element box is now 220 pixels wide, since we've added 10 pixels of padding to the right and left of the content. The margins will now extend another 20 pixels to both sides for an overall element box width of 260 pixels. This is illustrated in [Figure 1-6](#).

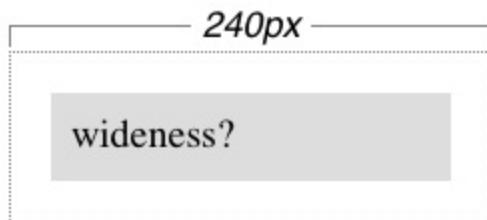


**Figure 1-6. Additive padding and margin**

Of course, if we change the styles to use the border box for `box-sizing`, then the results would be different. In that case, the visible box would be 200 pixels wide with a content width of 180 pixels, and a total of 40 pixels of margin to the sides, giving an overall box width of 240 pixels, as illustrated

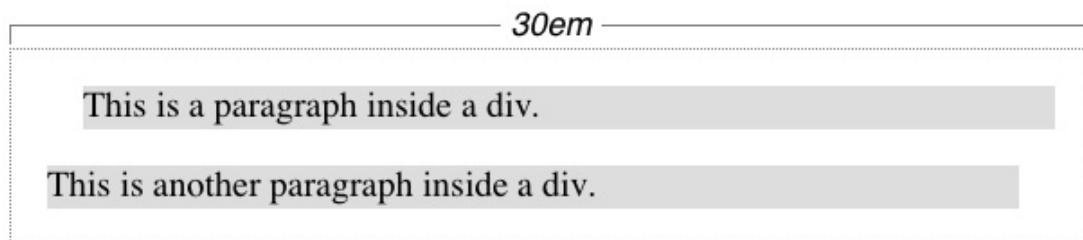
in [Figure 1-7](#).

In either case, there is a simple rule that says that the sum of the horizontal components of a block box in the normal flow always equals the width of the containing block. Let's consider two paragraphs within a `div` whose margins have been set to be `1em`, and whose `box-sizing` value is the default. The content width (the value of `width`) of each paragraph, plus its left and right padding, borders, and margins, always adds up to the width of the `div`'s content area.



**Figure 1-7. Subtracted padding**

Let's say the width of the `div` is `30em`. That makes the sum total of the content width, padding, borders, and margins of each paragraph `30 em`. In [Figure 1-8](#), the “blank” space around the paragraphs is actually their margins. If the `div` had any padding, there would be even more blank space, but that isn't the case here.



**Figure 1-8. Element boxes are as wide as the width of their containing block**

# Horizontal Properties

The “seven properties” of horizontal formatting are: `margin-left`, `border-left`, `padding-left`, `width`, `padding-right`, `border-right`, and `margin-right`. These properties relate to the horizontal layout of block boxes and are diagrammed in [Figure 1-9](#).

The values of these seven properties must add up to the width of the element’s containing block, which is usually the value of `width` for a block element’s parent (since block-level elements nearly always have block-level elements for parents).

Of these seven properties, only three may be set to `auto`: the width of the element’s content and the left and right margins. The remaining properties must be set either to specific values or default to a width of zero. [Figure 1-10](#) shows which parts of the box can take a value of `auto` and which cannot.

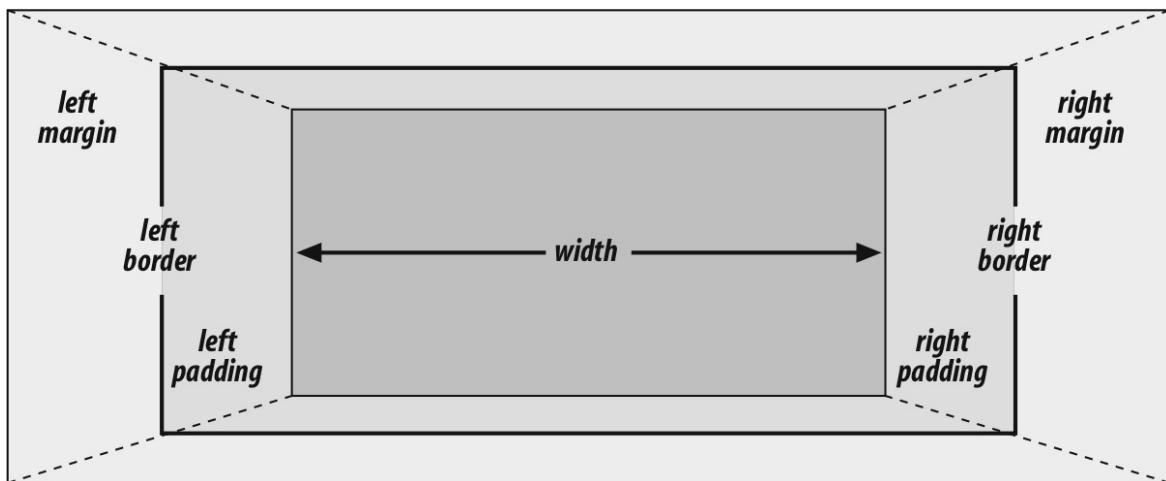
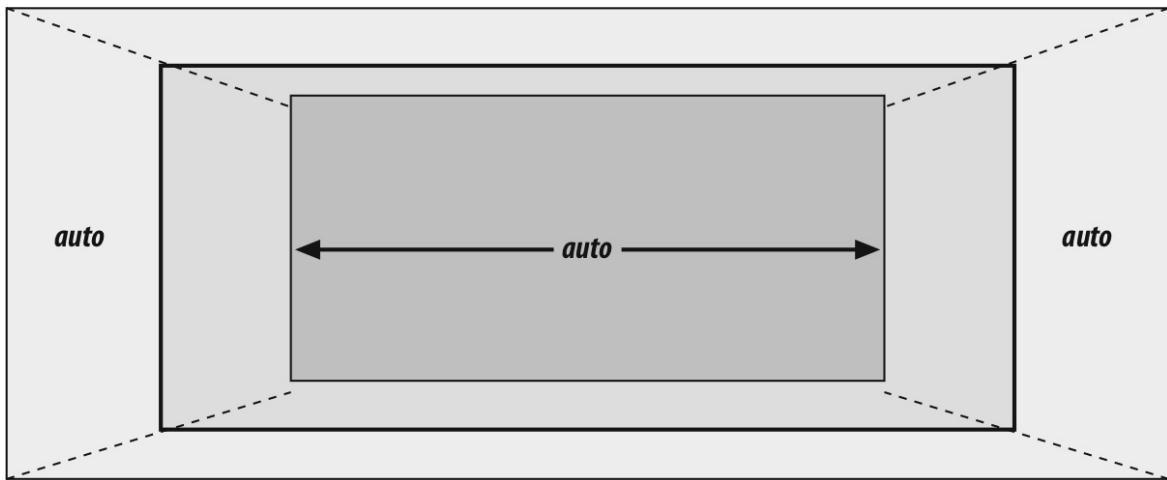


Figure 1-9. The “seven properties” of horizontal formatting



**Figure 1-10. Horizontal properties that can be set to `auto`**

`width` must either be set to `auto` or a nonnegative value of some type. When you do use `auto` in horizontal formatting, different effects can occur.

# Using auto

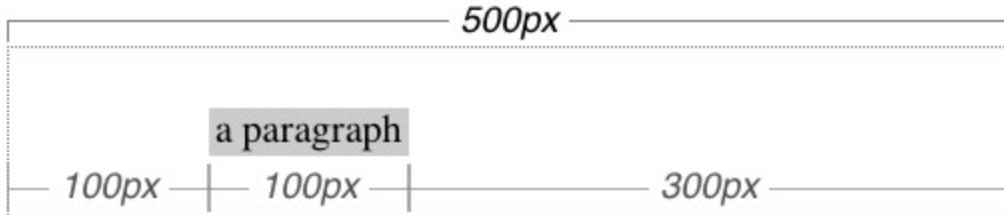
If you set `width`, `margin-left`, or `margin-right` to a value of `auto`, and give the remaining two properties specific values, then the property that is set to `auto` is set to the length required to make the element box's width equal to the parent element's width. In other words, let's say the sum of the seven properties must equal 500 pixels, no padding or borders are set, the right margin and width are set to `100px`, and the left margin is set to `auto`. The left margin will thus be 300 pixels wide:

```
div {width: 500px;}  
p {margin-left: auto; margin-right: 100px;  
   width: 100px;} /* 'auto' left margin evaluates to 300px */
```

In a sense, `auto` can be used to make up the difference between everything else and the required total. However, what if all three of these properties are set to `100px` and *none* of them are set to `auto`?

In the case where all three properties are set to something other than `auto`—or, in CSS terminology, when these formatting properties have been *overconstrained*—then `margin-right` is *always* forced to be `auto`. This means that if both margins and the width are set to `100px`, then the user agent will reset the right margin to `auto`. The right margin's width will then be set according to the rule that one `auto` value “fills in” the distance needed to make the element's overall width equal that of its containing block. [Figure 1-11](#) shows the result of the following markup:

```
div {width: 500px;}  
p {margin-left: 100px; margin-right: 100px;  
   width: 100px;} /* right margin forced to be 300px */
```



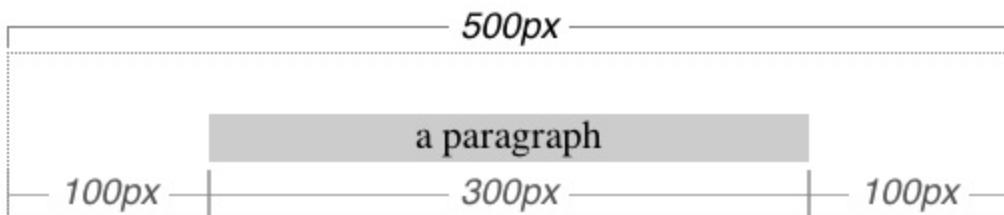
**Figure 1-11. Overriding the margin-right setting**

If both margins are set explicitly, and `width` is set to `auto`, then `width` will be whatever value is needed to reach the required total (which is the content width of the parent element). The results of the following markup are shown in [Figure 1-12](#):

```
p {margin-left: 100px; margin-right: 100px; width: auto;}
```

The case shown in [Figure 1-12](#) is the most common case, since it is equivalent to setting the margins and not declaring anything for the `width`. The result of the following markup is exactly the same as that shown in [Figure 1-12](#):

```
p {margin-left: 100px; margin-right: 100px;} /* same as before */
```



**Figure 1-12. Automatic width**

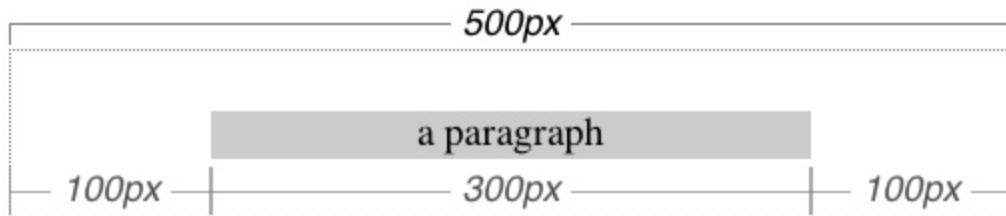
You might be wondering what happens if `box-sizing` is set to, say, `padding-box`. The discussion here tends to assume that the default of `content-box` is used, but all the same principles described here apply, which is why this section only talked about `width` and the side margins without introducing any

padding or borders. The handling of `width: auto` in this section and the following sections is the same regardless of the value of `box-sizing`. The details of what gets placed where inside the `box-sizing`-defined box may vary, but the treatment of `auto` values does not, because `box-sizing` determines what `width` refers to, not how it behaves in relation to the margins.

# More Than One auto

Now let's see what happens when two of the three properties (`width`, `margin-left`, and `margin-right`) are set to `auto`. If both margins are set to `auto`, as shown in the following code, then they are set to equal lengths, thus centering the element within its parent. This is illustrated in [Figure 1-13](#).

```
div {width: 500px;}  
p {width: 300px; margin-left: auto; margin-right: auto;}  
/* each margin is 100 pixels wide, because (500-300)/2 = 100
```



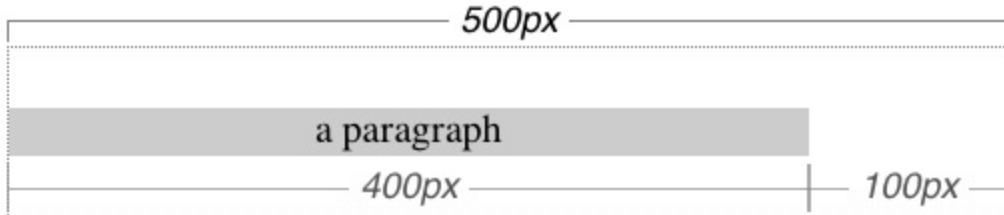
**Figure 1-13.** Setting an explicit width

Setting both margins to equal lengths is the correct way to center elements within block boxes in the normal flow. (There are other methods to be found with flexible box and grid layout, but they're beyond the scope of this text.)

Another way of sizing elements is to set one of the margins and the `width` to `auto`. The margin set to be `auto` is reduced to zero:

```
div {width: 500px;}  
p {margin-left: auto; margin-right: 100px;  
  width: auto;} /* left margin evaluates to 0; width becomes 400px
```

The `width` is then set to the value necessary to make the element fill its containing block; in the preceding example, it would be 400 pixels, as shown in [Figure 1-14](#).



**Figure 1-14. What happens when both the width and right margin are auto**

Finally, what happens when all three properties are set to `auto`? The answer is simple: both margins are set to zero, and the `width` is made as wide as possible. This result is the same as the default situation, when no values are explicitly declared for margins or the width. In such a case, the margins default to zero and the `width` defaults to `auto`.

Note that since horizontal margins do not collapse, the padding, borders, and margins of a parent element can affect its children. The effect is indirect in that the margins (and so on) of an element can induce an offset for child elements. The results of the following markup are shown in [Figure 1-15](#):

```
div {padding: 50px; background: silver;}
p {margin: 30px; padding: 0; background: white;}
```

# Negative Margins

So far, this probably all seems rather straightforward, and you may be wondering why I said things could be complicated. Well, there's another side to margins: the negative side. That's right, it's possible to set negative values for margins. Setting negative margins can result in some interesting effects.

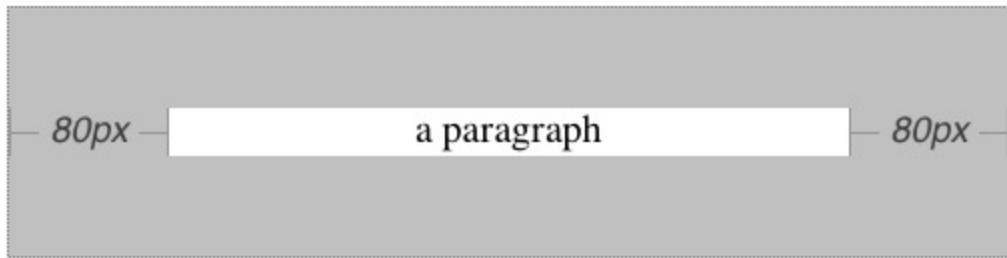


Figure 1-15. Offset is implicit in the parent's margins and padding

Remember that the total of the seven horizontal properties always equals the `width` of the parent element. As long as all properties are zero or greater, an element can never be wider than its parent's content area. However, consider the following markup, depicted in [Figure 1-16](#):

```
div {width: 500px; border: 3px solid black;}  
p.wide {margin-left: 10px; width: auto; margin-right: -50px; }
```

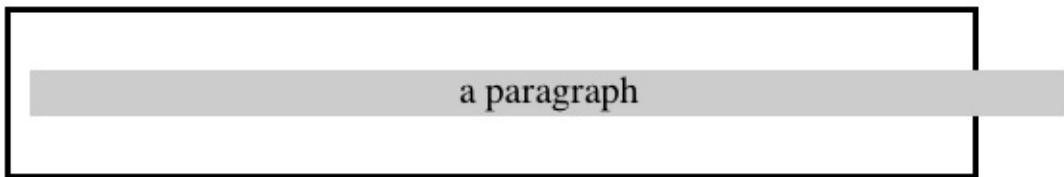


Figure 1-16. Wider children through negative margins

Yes indeed, the child element is wider than its parent! This is mathematically correct:

$$10\text{px} + 0 + 0 + 540\text{px} + 0 + 0 - 50\text{px} = 500\text{px}$$

The `540px` is the evaluation of `width: auto`, which is the number needed to balance out the rest of the values in the equation. Even though it leads to a child element sticking out of its parent, the specification hasn't been violated because the values of the seven properties add up to the required total. It's a semantic dodge, but it's valid behavior.

Now, let's add some borders to the mix:

```
div {width: 500px; border: 3px solid black;}  
p.wide {margin-left: 10px; width: auto; margin-right: -50px;  
border: 3px solid gray;}
```

The resulting change will be a reduction in the evaluated width of `width`:

$$10\text{px} + 3\text{px} + 0 + 534\text{px} + 0 + 3\text{px} - 50\text{px} = 500\text{px}$$

If we were to introduce padding, then the value of `width` would drop even more.

Conversely, it's possible to have `auto` right margins evaluate to negative amounts. If the values of other properties force the right margin to be negative in order to satisfy the requirement that elements be no wider than their containing block, then that's what will happen. Consider:

```
div {width: 500px; border: 3px solid black;}  
p.wide {margin-left: 10px; width: 600px; margin-right: auto;  
border: 3px solid gray;}
```

The equation will work out like this:

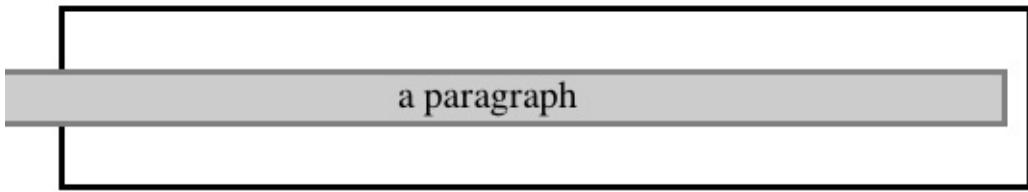
$$10\text{px} + 3\text{px} + 0 + 600\text{px} + 0 + 3\text{px} - 116\text{px} = 500\text{px}$$

The right margin will evaluate to `-116px`. Even if we'd given it a different explicit value, it would still be forced to `-116px` because of the rule stating that when an element's dimensions are overconstrained, the right margin is reset to whatever is needed to make the numbers work out correctly. (Except

in right-to-left languages, where the left margin would be overruled instead.)

Let's consider another example, illustrated in [Figure 1-17](#), where the left margin is set to be negative:

```
div {width: 500px; border: 3px solid black;}  
p.wide {margin-left: -50px; width: auto; margin-right: 10px;  
border: 3px solid gray;}
```



**Figure 1-17. Setting a negative left margin**

With a negative left margin, not only does the paragraph spill beyond the borders of the `div`, but it also spills beyond the edge of the browser window itself!

Remember that padding, borders, and content widths (and heights) can never be negative. Only margins can be less than zero.

# Percentages

When it comes to percentage values for the width, padding, and margins, the same basic rules apply. It doesn't really matter whether the values are declared with lengths or percentages.

Percentages can be very useful. Suppose we want an element's content to be two-thirds the width of its containing block, the right and left padding to be 5% each, the left margin to be 5%, and the right margin to take up the slack. That would be written something like:

```
<p style="width: 67%; padding-right: 5%; padding-left: 5%; margin-left: 5%;">playing percentages</p>
```

The right margin would evaluate to 18% ( $100\% - 67\% - 5\% - 5\% - 5\%$ ) of the width of the containing block.

Mixing percentages and length units can be tricky, however. Consider the following example:

```
<p style="width: 67%; padding-right: 2em; padding-left: 2em; margin-left: 5em;">mixed lengths</p>
```

In this case, the element's box can be defined like this:

$$5\text{em} + 0 + 2\text{em} + 67\% + 2\text{em} + 0 + \text{auto} = \text{containing block width}$$

In order for the right margin's width to evaluate to zero, the element's containing block must be 27.272727 em wide (with the content area of the element being 18.272727 em wide). Any wider than that, and the right margin will evaluate to a positive value. Any narrower and the right margin will be a negative value.

The situation gets even more complicated if we start mixing length-value unity types, like this:

```
<p style="width: 67%; padding-right: 15px; padding-left: 10px; margin-right: auto;">
```

```
margin-left: 5em;">more mixed lengths</p>
```

And, just to make things more complex, borders cannot accept percentage values, only length values. The bottom line is that it isn't really possible to create a fully flexible element based solely on percentages unless you're willing to avoid using borders or use some of the more experimental approaches such as flexible box layout.

# Replaced Elements

So far, we've been dealing with the horizontal formatting of nonreplaced block boxes in the normal flow of text. Block-level replaced elements are a bit simpler to manage. All of the rules given for nonreplaced blocks hold true, with one exception: if `width` is `auto`, then the `width` of the element is the content's intrinsic width. The image in the following example will be 20 pixels wide because that's the width of the original image:

```

```

If the actual image were 100 pixels wide instead, then it would be laid out as 100 pixels wide.

It's possible to override this rule by assigning a specific value to `width`. Suppose we modify the previous example to show the same image three times, each with a different width value:

```
  
  

```

This is illustrated in [Figure 1-18](#).

Note that the height of the elements also increases. When a replaced element's `width` is changed from its intrinsic width, the value of `height` is scaled to match, unless `height` has been set to an explicit value of its own. The reverse is also true: if `height` is set, but `width` is left as `auto`, then the `width` is scaled proportionately to the change in `height`.



**Figure 1-18. Changing replaced element widths**

Now that you're thinking about height, let's move on to the vertical formatting of normal-flow block box.

# Vertical Formatting

Like horizontal formatting, the vertical formatting of block boxes has its own set of interesting behaviors. An element's content determines the default height of an element. The width of the content also affects height; the skinnier a paragraph becomes, for example, the taller it has to be in order to contain all of the inline content within it.

In CSS, it is possible to set an explicit height on any block-level element. If you do this, the resulting behavior depends on several other factors. Assume that the specified height is greater than that needed to display the content:

```
<p style="height: 10em;">
```

In this case, the extra height has a visual effect somewhat like extra padding. But suppose the height is *less* than what is needed to display the content:

```
<p style="height: 3.33em;">
```

When that happens, the browser is supposed to provide a means of viewing all content without increasing the height of the element box. In a case where the content of an element is taller than the height of its box, the actual behavior of a user agent will depend on the value of the property `overflow`. Two alternatives are shown in [Figure 1-19](#).

Under CSS1, user agents can ignore any value of `height` other than `auto` if an element is not a replaced element (such as an image). In CSS2 and later, the value of `height` cannot be ignored, except in one specific circumstance involving percentage values. We'll talk about that in a moment.

Just as with `width`, `height` defines the content area's height by default, as opposed to the height of the visible element box. Any padding, borders, or margins on the top or bottom of the element box are *added* to the value for `height`, unless the value of `box-sizing` is different than `content-box`.

This paragraph is 10em tall. It has more than enough room to show all its content.

This paragraph is 3em tall. It may therefore lack the necessary height to contain all its content. What happens then is down to the author's styles and the browser's capabilities.

This paragraph is 3em tall. It may therefore lack the

**Figure 1-19. Heights that don't match the element's content height**

# Vertical Properties

As was the case with horizontal formatting, vertical formatting also has seven related properties: `margin-top`, `border-top`, `padding-top`, `height`, `padding-bottom`, `border-bottom`, and `margin-bottom`. These properties are diagrammed in [Figure 1-20](#).

The values of these seven properties must equal the height of the block box's containing block. This is usually the value of `height` for a block box's parent (since block-level elements nearly always have block-level elements for parents).

Only three of these seven properties may be set to `auto`: the `height` of the element, and the top and bottom margins. The top and bottom padding and borders must be set to specific values or else they default to a width of zero (assuming no border-style is declared). If `border-style` has been set, then the thickness of the borders is set to be the vaguely defined value `medium`. [Figure 1-21](#) provides an illustration for remembering which parts of the box may have a value of `auto` and which may not.

Interestingly, if either `margin-top` or `margin-bottom` is set to `auto` for a block box in the normal flow, they both automatically evaluate to `0`. A value of `0` unfortunately prevents easy vertical centering of normal-flow boxes in their containing blocks. It also means that if you set the top and bottom margins of an element to `auto`, they are effectively reset to `0` and removed from the element box.

## Note

The handling of `auto` top and bottom margins is different for positioned elements, as well as flexible-box elements.

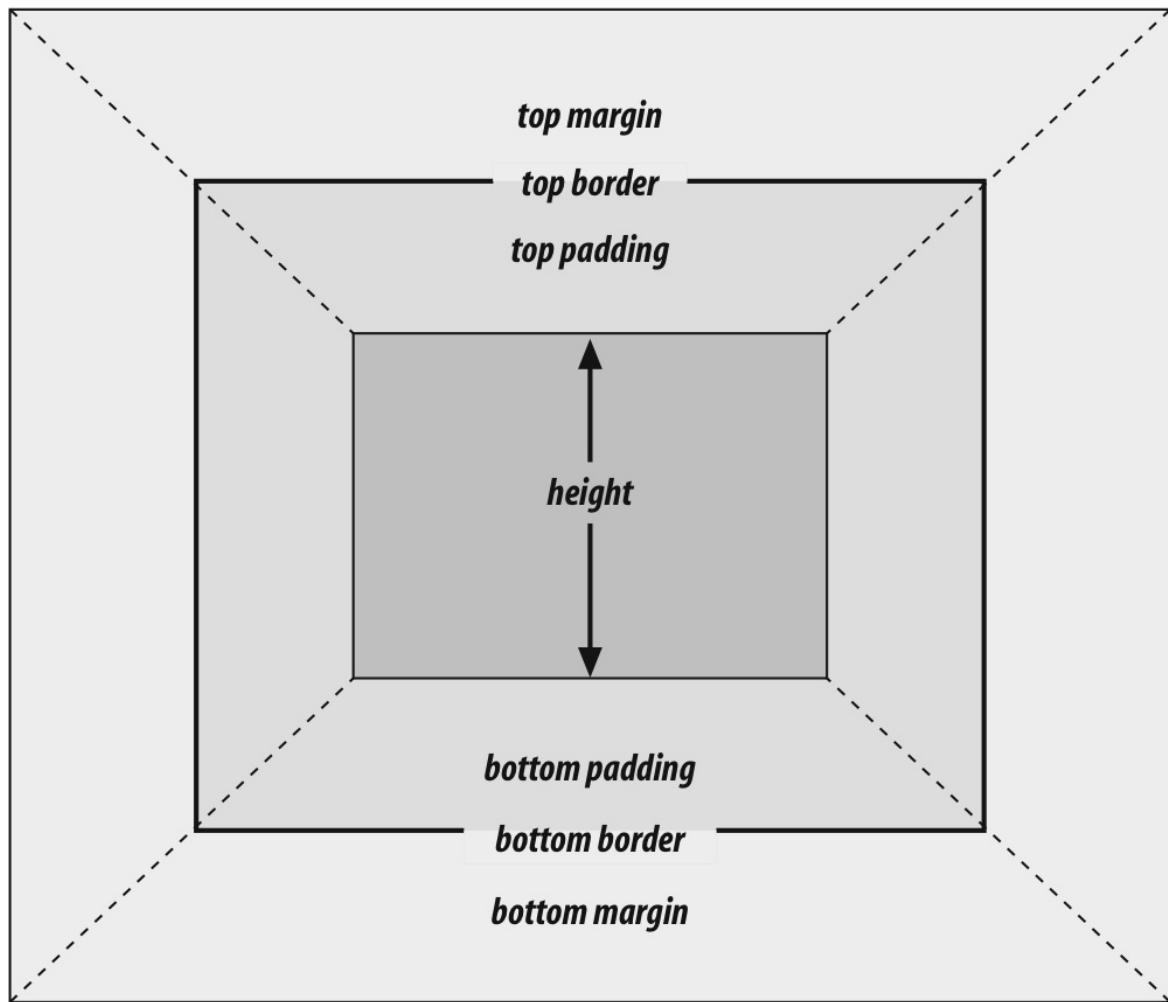


Figure 1-20. The “seven properties” of vertical formatting

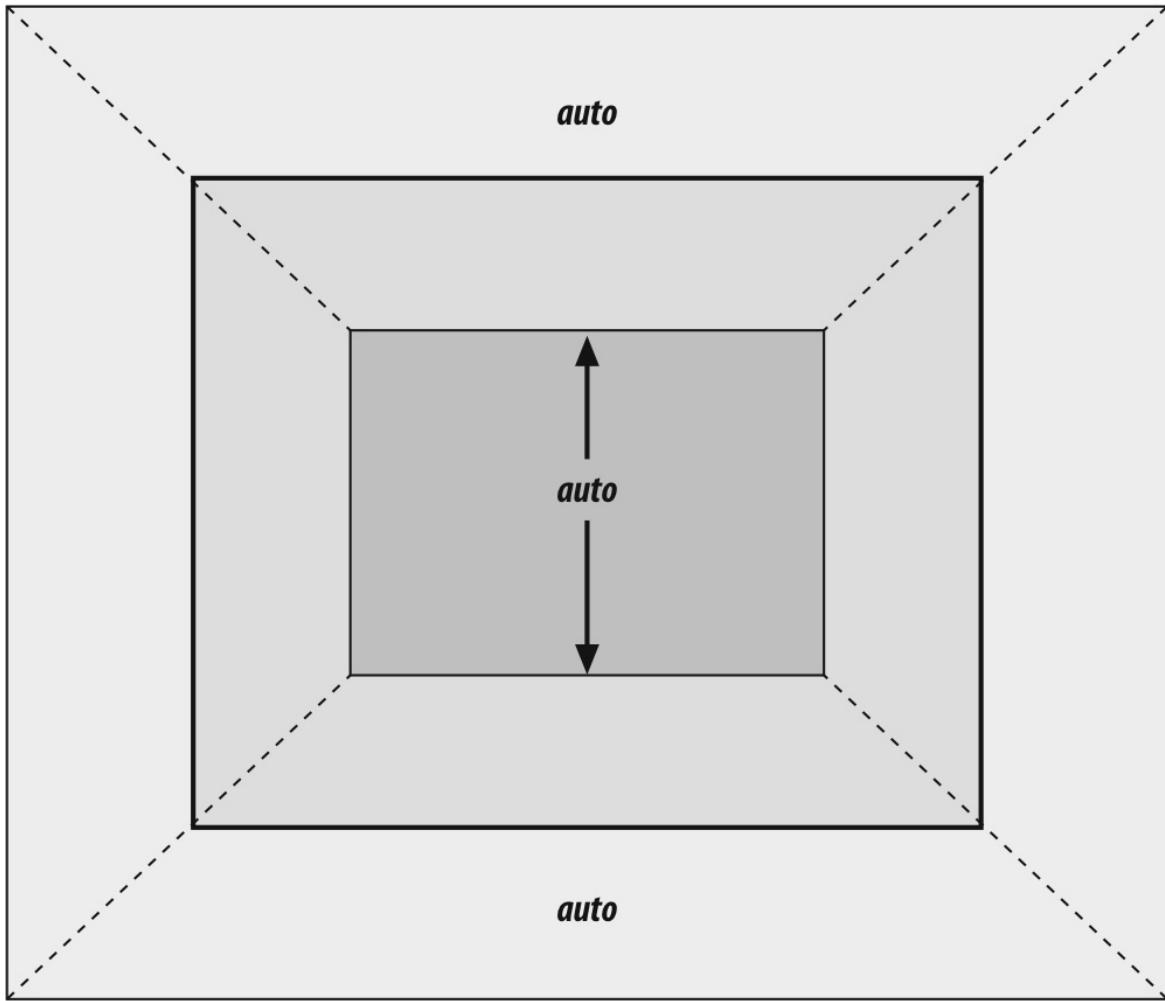
`height` must be set to `auto` or to a nonnegative value of some type; it can never be less than zero.

# Percentage Heights

You already saw how length-value heights are handled, so let's spend a moment on percentages. If the height of a normal-flow block box is set to a percentage value, then that value is taken as a percentage of the height of the box's containing block. Given the following markup, the resulting paragraph will be 3 em tall:

```
<div style="height: 6em;">  
  <p style="height: 50%;">Half as tall</p>  
</div>
```

Since setting the top and bottom margins to `auto` will give them zero height, the only way to vertically center the element in this particular case would be to set them both to `25%`—and even then, the box would be centered, not the content within it.

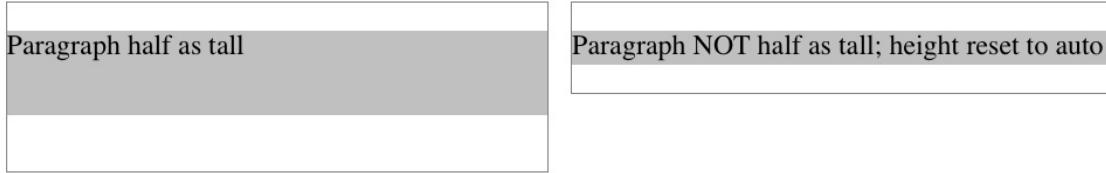


**Figure 1-21.** Vertical properties that can be set to auto

However, in cases where the height of the containing block is *not* explicitly declared, percentage heights are reset to `auto`. If we changed the previous example so that the `height` of the `div` is `auto`, the paragraph will now be exactly as tall as the `div` itself:

```
<div style="height: auto;">
  <p style="height: 50%;">NOT half as tall; height reset to aut
</div>
```

These two possibilities are illustrated in [Figure 1-22](#). (The spaces between the paragraph borders and the `div` borders are the top and bottom margins on the paragraphs.)



**Figure 1-22. Percentage heights in different circumstances**

Before we move on, take a closer look at the first example in [Figure 1-22](#), the half-as-tall paragraph. It may be half as tall, but it isn't vertically centered. That's because the containing `div` is 6 em tall, which means the half-as-tall paragraph is 3 em tall. It has top and bottom margins of 1 em, so its overall box height is 5 em. That means there is actually 2 em of space between the bottom of the paragraph's visible box and the `div`'s bottom border, not 1 em. It might seem a bit odd at first glance, but it makes sense once you work through the details.

# Auto Heights

In the simplest case, a normal-flow block box with `height: auto` is rendered just high enough to enclose the line boxes of its inline content (including text). If an auto-height, normal-flow block box has only block-level children, then its default height will be the distance from the top of the topmost block-level child's outer border edge to the bottom of the bottommost block-level child's outer bottom border edge. Therefore, the margins of the child elements will “stick out” of the element that contains them. (This behavior is explained in the next section.)

However, if the block-level element has either top or bottom padding, or top or bottom borders, then its height will be the distance from the top of the outer-top margin edge of its topmost child to the outer-bottom margin edge of its bottommost child:

```
<div style="height: auto;  
background: silver;">  
  <p style="margin-top: 2em; margin-bottom: 2em;">A paragraph!<  
/></div>  
<div style="height: auto; border-top: 1px solid; border-bottom: 1  
background: silver;">  
  <p style="margin-top: 2em; margin-bottom: 2em;">Another parag  
</div>
```

Both of these behaviors are demonstrated in [Figure 1-23](#).

If we changed the borders in the previous example to padding, the effect on the height of the `div` would be the same: it would still enclose the paragraph's margins within it.

A paragraph!

Another paragraph!

**Figure 1-23.** Auto heights with block-level children

# Collapsing Vertical Margins

One other important aspect of vertical formatting is the *collapsing* of vertically adjacent margins. Collapsing behavior applies only to margins. Padding and borders, where they exist, never collapse with anything.

An unordered list, where list items follow one another, is a perfect example of margin collapsing. Assume that the following is declared for a list that contains five items:

```
li {margin-top: 10px; margin-bottom: 15px;}
```

Each list item has a 10-pixel top margin and a 15-pixel bottom margin. When the list is rendered, however, the distance between adjacent list items is 15 pixels, not 25. This happens because, along the vertical axis, adjacent margins are collapsed. In other words, the smaller of the two margins is eliminated in favor of the larger. [Figure 1-24](#) shows the difference between collapsed and uncollapsed margins.

Correctly implemented user agents collapse vertically adjacent margins, as shown in the first list in [Figure 1-24](#), where there are 15-pixel spaces between each list item. The second list shows what would happen if the user agent didn't collapse margins, resulting in 25-pixel spaces between list items.

Another word to use, if you don't like "collapse," is "overlap." Although the margins are not really overlapping, you can visualize what's happening using the following analogy.

Imagine that each element, such as a paragraph, is a small piece of paper with the content of the element written on it. Around each piece of paper is some amount of clear plastic, which represents the margins. The first piece of paper (say an `h1` piece) is laid down on the canvas. The second (a paragraph) is laid below it and then slid up until the edge of one of the piece's plastic touches the edge of the other's paper. If the first piece of paper has half an inch of plastic along its bottom edge, and the second has a third of an inch along its top, then when they slide together, the first piece's plastic will touch the top

edge of the second piece of paper. The two are now done being placed on the canvas, and the plastic attached to the pieces is overlapping.

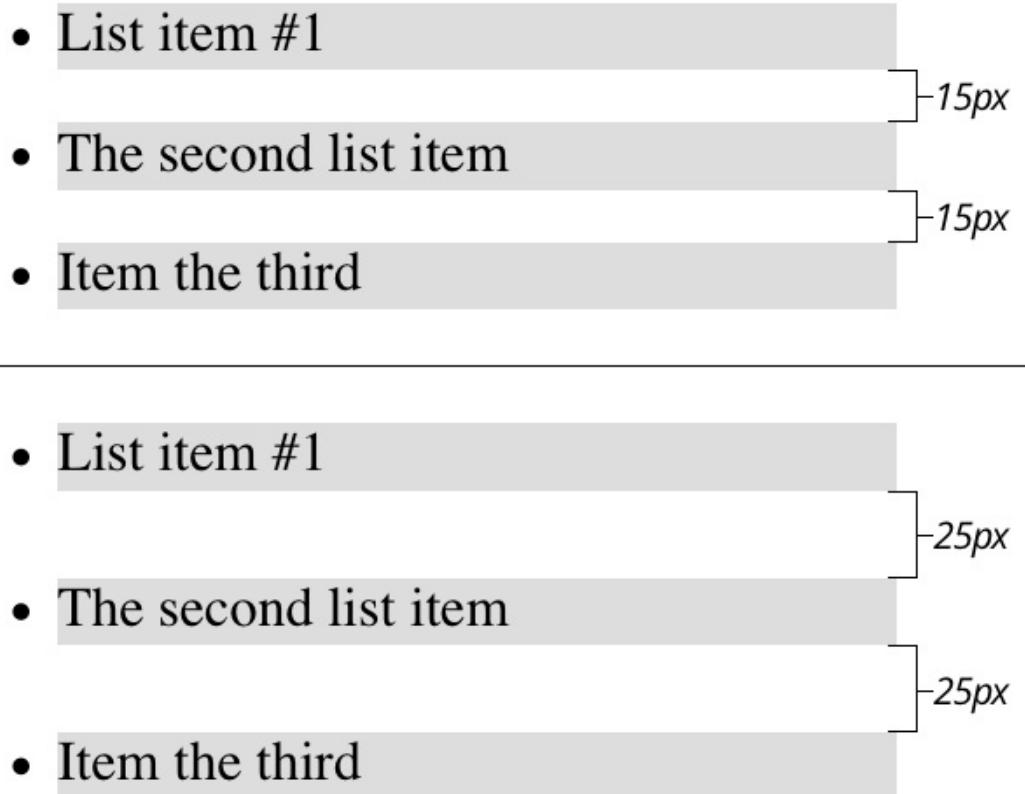


Figure 1-24. Collapsed versus uncollapsed margins

Collapsing also occurs where multiple margins meet, such as at the end of a list. Adding to the earlier example, let's assume the following rules apply:

```
ul {margin-bottom: 15px;}\nli {margin-top: 10px; margin-bottom: 20px;}\nh1 {margin-top: 28px;}
```

The last item in the list has a bottom margin of 20 pixels, the bottom margin of the `ul` is 15 pixels, and the top margin of a succeeding `h1` is 28 pixels. So once the margins have been collapsed, the distance between the end of the `li` and the beginning of the `h1` is 28 pixels, as shown in [Figure 1-25](#).

Now, recall the examples from the previous section, where the introduction

of a border or padding on a containing block would cause the margins of its child elements to be contained within it. We can see this behavior in operation by adding a border to the `ul` element in the previous example:

```
ul {margin-bottom: 15px; border: 1px solid;}  
li {margin-top: 10px; margin-bottom: 20px;}  
h1 {margin-top: 28px;}
```

leading up to the end of the list item, as well as the end of the list itself.

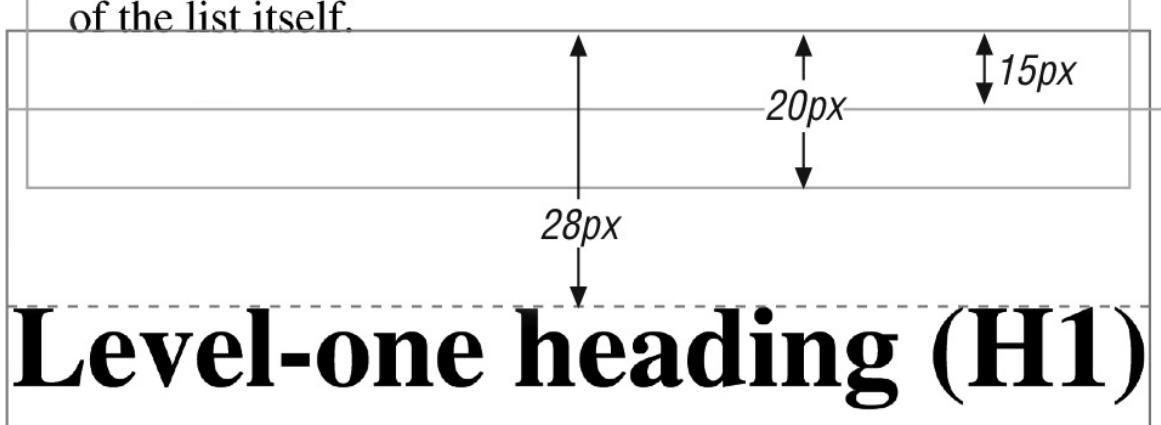
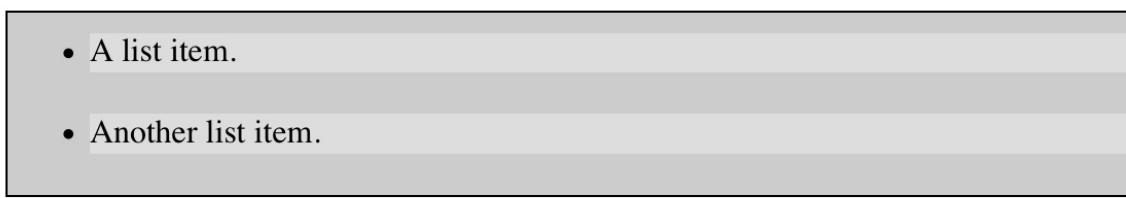


Figure 1-25. Collapsing in detail

With this change, the bottom margin of the `li` element is now placed inside its parent element (the `ul`). Therefore, the only margin collapsing that takes place is between the `ul` and the `h1`, as illustrated in [Figure 1-26](#).



## A Heading-1

Figure 1-26. Collapsing (or not) with borders added to the mix

# Negative Margins and Collapsing

Negative margins do have an impact on vertical formatting, and they affect how margins are collapsed. If negative vertical margins are set, then the browser should take the absolute maximum of both margins. The absolute value of the negative margin is then subtracted from the positive margin. In other words, the negative is added to the positive, and the resulting value is the distance between the elements. [Figure 1-27](#) provides two concrete examples.

This paragraph has a bottom margin of 0 (zero).  
This paragraph has a top margin of 0 (zero).

This paragraph has a bottom margin of 0.75em (three-quarters of an em).  
This paragraph has a top margin of -1em (negative one em).

This paragraph has a bottom margin of -0.75 (negative three-quarters of an em).  
This paragraph has a top margin of 0 (zero).

**Figure 1-27.** Examples of negative vertical margins

Notice the “pulling” effect of negative top and bottom margins. This is really no different from the way that negative horizontal margins cause an element to push outside of its parent. Consider:

```
p.neg {margin-top: -50px; margin-right: 10px;  
margin-left: 10px; margin-bottom: 0;}
```

```

border: 3px solid gray; }

<div style="width: 420px; background-color: silver; padding: 10px
            margin-top: 50px; border: 1px solid;">
    <p class="neg">
        A paragraph.
    </p>

    A div.

</div>

```

As we see in [Figure 1-28](#), the paragraph has simply been pulled upward by its negative top margin. Note that the content of the `div` that follows the paragraph in the markup has also been pulled upward 50 pixels. In fact, every bit of normal-flow content that follows the paragraph is also pulled upward 50 pixels.



**Figure 1-28. The effects of a negative top margin**

Now compare the following markup to the situation shown in [Figure 1-29](#):

```

p.neg {margin-bottom: -50px; margin-right: 10px;
       margin-left: 10px; margin-top: 0;
       border: 3px solid gray;}

<div style="width: 420px; margin-top: 50px;">
    <p class="neg">
        A paragraph.
    </p>
</div>
<p>
    The next paragraph.
</p>

```



- A list item.
- Another list item.

# A Heading-1

Figure 1-30. Collapsing margins and negative margins, in detail

# List Items

List items have a few special rules of their own. They are typically preceded by a marker, such as a small dot or a number. This marker isn't actually part of the list item's content area, so effects like those illustrated in [Figure 1-31](#) are common.

CSS1 said very little about the placement and effects of these markers with regard to the layout of a document. CSS2 introduced properties specifically designed to address this issue, such as `marker-offset`. However, a lack of implementations and changes in thinking caused this to be dropped from CSS2.1, and work is being done to reintroduce the idea (if not the specific syntax) to CSS. Accordingly, the placement of markers is largely beyond the control of authors, at least as of this writing.

The marker attached to a list item element can be either outside the content of the list item or treated as an inline marker at the beginning of the content, depending on the value of the property `list-style-position`. If the marker is brought inside, then the list item will interact with its neighbors exactly like a block-level element, as illustrated in [Figure 1-32](#).

If the marker stays outside the content, then it is placed some distance from the left content edge of the content (in left-to-right languages). No matter how the list's styles are altered, the marker stays the same distance from the content edge. Occasionally, the markers may be pushed outside of the list element itself, as we can see in [Figure 1-32](#).

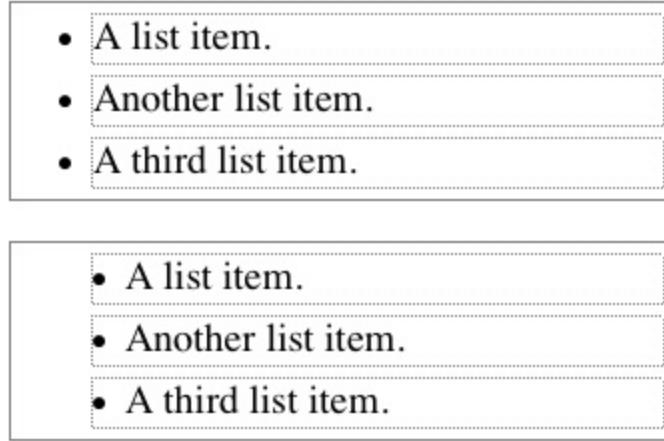
Remember that list-item boxes define containing blocks for their ancestor boxes, just like regular block boxes.

# Inline Elements

After block-level elements, inline elements are the most common. Setting box properties for inline elements takes us into more interesting territory than we've been so far. Some good examples of inline elements are the `em` tag and the `a` tag, both of which are nonreplaced elements, and images, which are replaced elements.

- A list item.
- Another list item.
- A third list item.
- Yet another list item.
- Listy!

**Figure 1-31.** The content of list items



**Figure 1-32. Markers inside and outside the list**

Note that none of the behavior described in this section applies to table elements. CSS2 introduced new properties and behaviors for handling tables and table content, and these elements behave in ways fairly distinct from either block-level or inline formatting. Table styling is beyond the scope of this book, as it's surprisingly complicated and exists rather in a world of its own.

Nonreplaced and replaced elements are treated somewhat differently in the inline context, and we'll look at each in turn as we explore the construction of inline elements.

# Line Layout

First, you need to understand how inline content is laid out. It isn't as simple and straightforward as block-level elements, which just generate block boxes and usually don't allow anything to coexist with them. By contrast, look *inside* a block-level element, such as a paragraph. You may well ask, how did all those lines of text get there? What controls their arrangement? How can I affect it?

In order to understand how lines are generated, first consider the case of an element containing one very long line of text, as shown in [Figure 1-33](#). Note that we've put a border around the line by wrapping the entire line in a `span` element and then assigning it a border style:

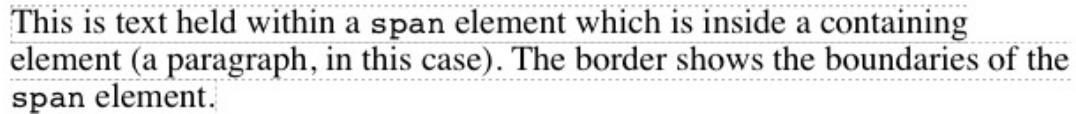
```
span {border: 1px dashed black;}
```

This is text held within a `span` element which is inside a containing element (a `p` element).

**Figure 1-33.** A single-line inline element

[Figure 1-33](#) shows the simplest case of an inline element contained by a block-level element. It's no different in its way than a paragraph with two words in it. The only differences are that, in [Figure 1-34](#), we have a few dozen words and most paragraphs don't contain an explicit inline element such as `span`.

In order to get from this simplified state to something more familiar, all we have to do is determine how wide the element should be, and then break up the line so that the resulting pieces will fit into the content width of the element. Therefore, we arrive at the state shown in [Figure 1-34](#).



This is text held within a `span` element which is inside a containing element (a paragraph, in this case). The border shows the boundaries of the `span` element.

Figure 1-34. A multiple-line inline element

Nothing has really changed. All we did was take the single line and break it into pieces, and then stack those pieces on top of each other.

In [Figure 1-34](#), the borders for each line of text also happen to coincide with the top and bottom of each line. This is true only because no padding has been set for the inline text. Notice that the borders actually overlap each other slightly; for example, the bottom border of the first line is just below the top border of the second line. This is because the border is actually drawn on the next pixel (assuming you're using a monitor) to the *outside* of each line. Since the lines are touching each other, their borders will overlap as shown in [Figure 1-34](#).

If we alter the `span` styles to have a background color, the actual placement of the lines becomes quite clear. Consider [Figure 1-35](#), which contains four paragraphs, each with a different value of `text-align` and each having the backgrounds of its lines `<span class="keep-together">filled in.</span>`

This paragraph assumes the style `text-align: left;`, which causes the line boxes within the element to line up along the left inner content edge of the paragraph.

This paragraph assumes the style `text-align: right;`, which causes the line boxes within the element to line up along the right inner content edge of the paragraph.

This paragraph assumes the style `text-align: center;`, which causes the line boxes within the element to line up their centers with the center of the content area of the paragraph.

This paragraph assumes the style `text-align: justify;`, which causes the line boxes within the element to align their left and right edges to the left and right inner content edges of the paragraph. The exception is the last line box, whose right edge does not align with the right content edge of the paragraph. (In right-to-left languages, the left edge of the last line box would not be so aligned.)

**Figure 1-35. Showing lines in different alignments**

As we can see, not every line reaches to the edge of its parent paragraph's content area, which has been denoted with a dotted gray border. For the left-aligned paragraph, the lines are all pushed flush against the left content edge of the paragraph, and the end of each line happens wherever the line is broken. The reverse is true for the right-aligned paragraph. For the centered paragraph, the centers of the lines are aligned with the center of the paragraph.

In the last case, where the value of `text-align` is `justify`, each line is forced to be as wide as the paragraph's content area so that the line's edges touch the content edges of the paragraph. The difference between the natural length of the line and the width of the paragraph is made up by altering the spacing between letters and words in each line. Therefore, the value of `word-spacing` can be overridden when the text is justified. (The value of `letter-spacing` cannot be overridden if it is a length value.)

That pretty well covers how lines are generated in the simplest cases. As you're about to see, however, the inline formatting model is far from simple.

# Basic Terms and Concepts

Before we go any further, let's review some basic terms of inline layout, which will be crucial in navigating the following sections:

## Anonymous text

This is any string of characters that is not contained within an inline element. Thus, in the markup `<p> I'm <em>so</em> happy!</p>`, the sequences “I'm” and “happy!” are anonymous text. Note that the spaces are part of the text since a space is a character like any other.

## Em box

This is defined in the given font, otherwise known as the character box. Actual glyphs can be taller or shorter than their em boxes. In CSS, the value of `font-size` determines the height of each em box.

## Content area

In nonreplaced elements, the content area can be one of two things, and the CSS specification allows user agents to choose which one. The content area can be the box described by the em boxes of every character in the element, strung together; or it can be the box described by the character glyphs in the element. In this book, I use the em box definition for simplicity's sake. In replaced elements, the content area is the intrinsic height of the element plus any margins, borders, or padding.

## Leading

Leading is the difference between the values of `font-size` and `line-height`. This difference is actually divided in half and is applied equally to the top and bottom of the content area. These additions to the content area are called, not surprisingly, *half-leading*. Leading is applied only to nonreplaced elements.

## Inline box

This is the box described by the addition of the leading to the content area. For nonreplaced elements, the height of the inline box of an element will be exactly equal to the value for `line-height`. For replaced elements, the height of the inline box of an element will be exactly equal to the content area, since leading is not applied to replaced elements.

## Line box

This is the shortest box that bounds the highest and lowest points of the inline boxes that are found in the line. In other words, the top edge of the line box is placed along the top of the highest inline box top, and the bottom of the line box is placed along the bottom of the lowest inline box bottom.

CSS also contains a set of behaviors and useful concepts that fall outside of the above list of terms and definitions:

- The content area is analogous to the content box of a block box.
- The background of an inline element is applied to the content area plus any padding.
- Any border on an inline element surrounds the content area plus any padding and border.
- Padding, borders, and margins on nonreplaced elements have no vertical effect on inline elements or the boxes they generate; that is, they do *not* affect the height of an element's inline box (and thus the line box that contains the element).
- Margins and borders on replaced elements *do* affect the height of the inline box for that element and, by implication, the height of the line box for the line that contains the element.

One more thing to note: inline boxes are vertically aligned within the line according to their values for the property `vertical-align`.

Before moving on, let's look at a step-by-step process for constructing a line box, which you can use to see how the various pieces of the line fit together to determine its height.

Determine the height of the inline box for each element in the line by following these steps:

1. Find the values of `font-size` and `line-height` for each inline nonreplaced element and text that is not part of a descendant inline element and combine them. This is done by subtracting the `font-size` from the `line-height`, which yields the leading for the box. The leading is split in half and applied to the top and bottom of each em box.
2. Find the values of `height`, `margin-top`, `margin-bottom`, `padding-top`, `padding-bottom`, `border-top-width`, and `border-bottom-width` for each replaced element and add them together.
3. Figure out, for each content area, how much of it is above the baseline for the overall line and how much of it is below the baseline. This is not an easy task: you must know the position of the baseline for each element and piece of anonymous text and the baseline of the line itself, and then line them all up. In addition, the bottom edge of a replaced element sits on the baseline for the overall line.
4. Determine the vertical offset of any elements that have been given a value for `vertical-align`. This will tell you how far up or down that element's inline box will be moved, and it will change how much of the element is above or below the baseline.
5. Now that you know where all of the inline boxes have come to rest, calculate the final line box height. To do so, just add the distance between the baseline and the highest inline box top to the distance between the baseline and the lowest inline box bottom.

Let's consider the whole process in detail, which is the key to intelligently styling inline content.

# Inline Formatting

First, know that all elements have a `line-height`, whether it's explicitly declared or not. This value greatly influences the way inline elements are displayed, so let's give it due attention.

Now let's establish how to determine the height of a line. A line's height (or the height of the line box) is determined by the height of its constituent elements and other content, such as text. It's important to understand that `line-height` actually affects inline elements and other inline content, *not* block-level elements—at least, not directly. We can set a `line-height` value for a block-level element, but the value will have a visual impact only as it's applied to inline content within that block-level element. Consider the following empty paragraph, for example:

```
<p style="line-height: 0.25em;"></p>
```

Without content, the paragraph won't have anything to display, so we won't see anything. The fact that this paragraph has a `line-height` of any value—be it `0.25em` or `25in`—makes no difference without some content to create a line box.

We can certainly set a `line-height` value for a block-level element and have that apply to all of the content within the block, whether or not the content is contained in any inline elements. In a certain sense, then, each line of text contained within a block-level element is its own inline element, whether or not it's surrounded by tags. If you like, picture a fictional tag sequence like this:

```
<p>
<line>This is a paragraph with a number of</line>
<line>lines of text which make up the</line>
<line>contents.</line>
</p>
```

Even though the `line` tags don't actually exist, the paragraph behaves as if they did—each line of text inherits styles from the paragraph. Therefore, you

only bother to create `line-height` rules for block-level elements so you don't have to explicitly declare a `line-height` for all of their inline elements, fictional or otherwise.

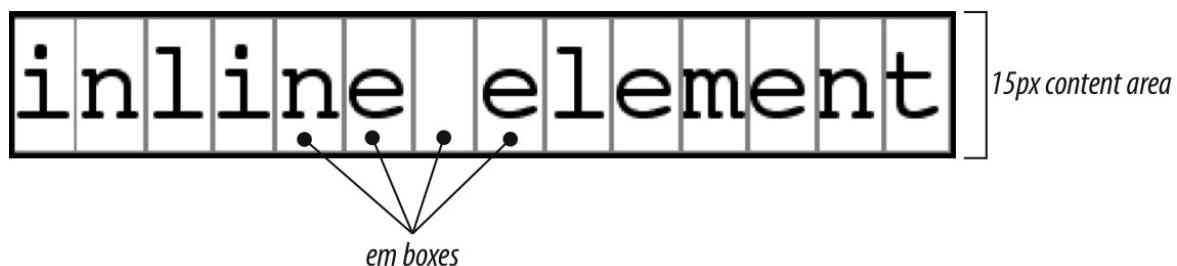
The fictional `line` element actually clarifies the behavior that results from setting `line-height` on a block-level element. According to the CSS specification, declaring `line-height` on a block-level element sets a *minimum* line box height for the content of that block-level element. Thus, declaring `p.spacious {line-height: 24pt;}` means that the *minimum* heights for each line box is 24 points. Technically, content can inherit this line height only if an inline element does so. Most text isn't contained by an inline element. Therefore, if you pretend that each line is contained by the fictional `line` element, the model works out very nicely.

# **Inline Nonreplaced Elements**

Building on your formatting knowledge, let's move on to the construction of lines that contain only nonreplaced elements (or anonymous text). Then you'll be in a good position to understand the differences between nonreplaced and replaced elements in inline layout.

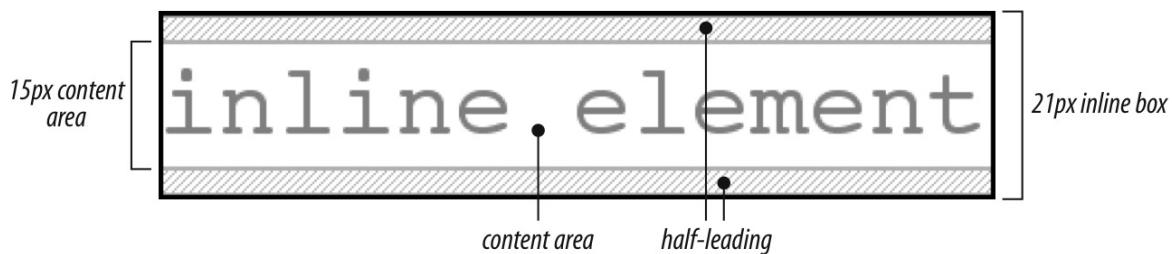
# Building the Boxes

First, for an inline nonreplaced element or piece of anonymous text, the value of `font-size` determines the height of the content area. If an inline element has a `font-size` of 15px, then the content area's height is 15 pixels because all of the em boxes in the element are 15 pixels tall, as illustrated in [Figure 1-36](#).



**Figure 1-36.** Em boxes determine content area height

The next thing to consider is the value of `line-height` for the element, and the difference between it and the value of `font-size`. If an inline nonreplaced element has a `font-size` of 15px and a `line-height` of 21px, then the difference is six pixels. The user agent splits the six pixels in half and applies half to the top and half to the bottom of the content area, which yields the inline box. This process is illustrated in [Figure 1-37](#).



**Figure 1-37.** Content area plus leading equals inline box

Let's assume that the following is true:

```
<p style="font-size: 12px; line-height: 12px;">
```

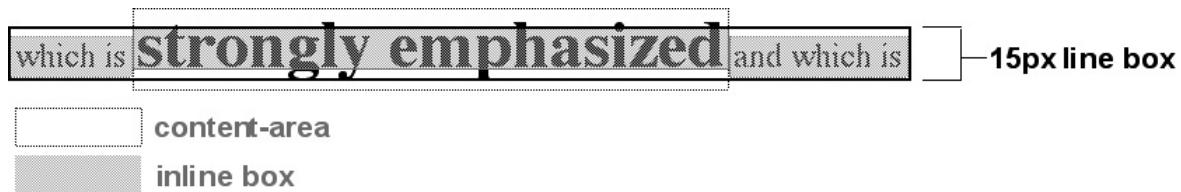
```
This is text, <em>some of which is emphasized</em>, plus other te  
which is strongly emphasized</st  
and which is<br>  
larger than the surrounding text.  
</p>
```

In this example, most of the text has a `font-size` of `12px`, while the text in one inline nonreplaced element has a size of `24px`. However, *all* of the text has a `line-height` of `12px` since `line-height` is an inherited property. Therefore, the `strong` element's `line-height` is also `12px`.

Thus, for each piece of text where both the `font-size` and `line-height` are `12px`, the content height does not change (since the difference between `12px` and `12px` is zero), so the inline box is 12 pixels high. For the strong text, however, the difference between `line-height` and `font-size` is `-12px`. This is divided in half to determine the half-leading (`-6px`), and the half-leading is added to both the top and bottom of the content height to arrive at an inline box. Since we're adding a negative number in both cases, the inline box ends up being 12 pixels tall. The 12-pixel inline box is centered vertically within the 24-pixel content height of the element, so the inline box is actually smaller than the content area.

So far, it sounds like we've done the same thing to each bit of text, and that all the inline boxes are the same size, but that's not quite true. The inline boxes in the second line, although they're the same size, don't actually line up because the text is all baseline-aligned (see [Figure 1-38](#)).

Since inline boxes determine the height of the overall line box, their placement with respect to each other is critical. The line box is defined as the distance from the top of the highest inline box in the line to the bottom of the lowest inline box, and the top of each line box butts up against the bottom of the line box for the preceding line. The result shown in [Figure 1-38](#) gives us the paragraph shown in [Figure 1-39](#).



**Figure 1-38. Inline boxes within a line**

This diagram illustrates inline boxes within a line of text. It consists of three horizontal lines representing the baseline of a line of text. The top line contains the text "This is text, *some of which is emphasized*, plus other text". The middle line contains the text "which is **strongly emphasized** and which is". The bottom line contains the text "larger than the surrounding text.". The word "strongly emphasized" is rendered in a large, bold font, demonstrating how its inline box overlaps the baseline of the surrounding text, creating irregular line heights.

**Figure 1-39. Line boxes within a paragraph**

As we can see in [Figure 1-39](#), the middle line is taller than the other two, but it still isn't big enough to contain all of the text within it. The anonymous text's inline box determines the bottom of the line box, while the top of the strong element's inline box sets the top of the line box. Because that inline box's top is inside the element's content area, the contents of the element spill outside the line box and actually overlap other line boxes. The result is that the lines of text look irregular.

**Note**

In just a bit, we'll explore ways to cope with this behavior and methods for achieving consistent baseline spacing.

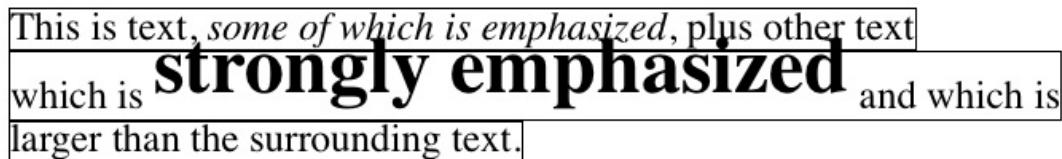
# Vertical Alignment

If we change the vertical alignment of the inline boxes, the same height determination principles apply. Suppose that we give the `strong` element a vertical alignment of `4px`:

```
<p style="font-size: 12px; line-height: 12px;">  
This is text, <em>some of which is emphasized</em>, plus other te  
which is <strong style="font-size: 24px; vertical-align: 4px;">st  
emphasized</strong> and that is<br>  
larger than the surrounding text.  

```

That small change raises the `strong` element four pixels, which pushes up both its content area and its inline box. Because the `strong` element's inline box top was already the highest in the line, this change in vertical alignment also pushes the top of the line box upward by four pixels, as shown in [Figure 1-40](#).



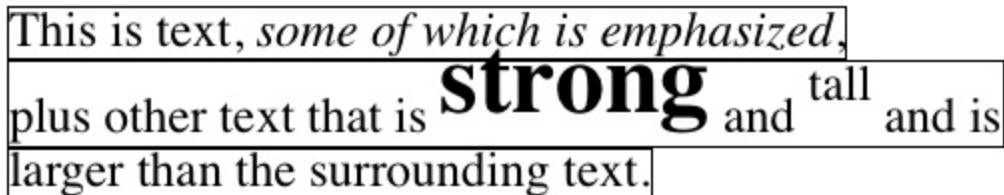
**Figure 1-40.** Vertical alignment affects line box height

Let's consider another situation. Here, we have another inline element in the same line as the strong text, and its alignment is other than the baseline:

```
<p style="font-size: 12px; line-height: 12px;">  
This is text, <em>some of which is emphasized</em>,<br>  
plus other text that is <strong style="font-size: 24px;">strong</strong>  
and <span style="vertical-align: top;">tall</span> and is<br>  
larger than the surrounding text.  

```

Now we have the same result as in our earlier example, where the middle line box is taller than the other line boxes. However, notice how the “tall” text is aligned in [Figure 1-41](#).



This is text, *some of which is emphasized*,  
plus other text that is **strong** and tall and is  
larger than the surrounding text.

**Figure 1-41. Aligning an inline element to the line box**

In this case, the top of the “tall” text’s inline box is aligned with the top of the line box. Since the “tall” text has equal values for `font-size` and `line-height`, the content height and inline box are the same. However, consider this:

```
<p style="font-size: 12px; line-height: 12px;">  
This is text, <em>some of which is emphasized</em>,<br>  
plus other text that is <strong style="font-size: 24px;">strong</strong>  
and <span style="vertical-align: top; line-height: 2px;">tall</span>  
larger than the surrounding text.  
</p>
```

Since the `line-height` for the “tall” text is less than its `font-size`, the inline box for that element is smaller than its content area. This tiny fact changes the placement of the text itself since the top of its inline box must be aligned with the top of the line box for its line. Thus, we get the result shown in [Figure 1-42](#).

On the other hand, we could set the “tall” text to have a `line-height` that is actually bigger than its `font-size`. For example:

```
<p style="font-size: 12px; line-height: 12px;">  
This is text, <em>some of which is emphasized</em>, plus other te  
that is <strong style="font-size: 24px;">strong</strong>
```

```
and <span style="vertical-align: top; line-height: 18px;">tall</span>
and that is<br>
larger than the surrounding text.
</p>
```

This is text, some of which is emphasized,  
plus other text that is **strong** and tall  
and is larger than the surrounding text.

The text is displayed in a single line. A yellow rectangular box highlights the word "strong". Above the word "strong", there is a small yellow box containing the word "tall". The entire line of text is enclosed in a light gray border.

Figure 1-42. Text protruding from the line box (again)

Since we've given the "tall" text a `line-height` of `18px`, the difference between `line-height` and `font-size` is six pixels. The half-leading of three pixels is added to the content area and results in an inline box that is 18 pixels tall. The top of this inline box aligns with the top of the line box. Similarly, the `vertical-align` value `bottom` will align the bottom of an inline element's inline box with the bottom of the line box.

In relation to the terms we've been using in this chapter, the effects of the assorted keyword values of `vertical-align` are:

`top`

Aligns the top of the element's inline box with the top of the containing line box

`bottom`

Aligns the bottom of the element's inline box with the bottom of the containing line box

`text-top`

Aligns the top of the element's inline box with the top of the parent's

content area

text-bottom

Aligns the bottom of the element's inline box with the bottom of the parent's content area

middle

Aligns the vertical midpoint of the element's inline box with  $0.5\text{ex}$  above the baseline of the parent

super

Moves the content area and inline box of the element upward. The distance is not specified and may vary by user agent

sub

The same as super, except the element is moved downward instead of upward

<percentage>

Shifts the element up or down the distance defined by taking the declared percentage of the element's value for `line-height`

# Managing the line-height

In previous sections, we saw that changing the `line-height` of an inline element can cause text from one line to overlap another. In each case, though, the changes were made to individual elements. So how can we affect the `line-height` of elements in a more general way in order to keep content from overlapping?

One way to do this is to use the `em` unit in conjunction with an element whose `font-size` has changed. For example:

```
p {line-height: 1em;}  
big {font-size: 250%; line-height: 1em;}
```

<p>

Not only does this paragraph have "normal" text, but it also<br>contains a line in which <big>some big text</big> is found.<br>This large text helps illustrate our point.

</p>

By setting a `line-height` for the `big` element, we increase the overall height of the line box, providing enough room to display the `big` element without overlapping any other text and without changing the `line-height` of all lines in the paragraph. We use a value of `1em` so that the `line-height` for the `big` element will be set to the same size as `big`'s `font-size`. Remember, `line-height` is set in relation to the `font-size` of the element itself, not the parent element. The results are shown in [Figure 1-43](#).

Not only does this paragraph have "normal" text, but it also contains a line in which **some big text** is found.  
This large text helps illustrate our point.

**Figure 1-43. Assigning the line-height property to inline elements**

Make sure you really understand the previous sections, because things will get trickier when we try to add borders. Let's say we want to put five-pixel borders around any hyperlink:

```
a:link {border: 5px solid blue;}
```

If we don't set a large enough `line-height` to accommodate the border, it will be in danger of overwriting other lines. We could increase the size of the inline box for unvisited links using `line-height`, as we did for the `big` element in the earlier example; in this case, we'd just need to make the value of `line-height` 10 pixels larger than the value of `font-size` for those links. However, that will be difficult if we don't actually know the size of the font in pixels.

Another solution is to increase the `line-height` of the paragraph. This will affect every line in the entire element, not just the line in which the bordered hyperlink appears:

```
p {line-height: 1.8em;}  
a:link {border: 5px solid blue;}
```

Because there is extra space added above and below each line, the border around the hyperlink doesn't impinge on any other line, as we can see in [Figure 1-44](#).

This approach works here, of course, because all of the text is the same size. If there were other elements in the line that changed the height of the line box, our border situation might also change. Consider the following:

```
p {font-size: 14px; line-height: 24px;}  
a:link {border: 5px solid blue;}  
big {font-size: 150%; line-height: 1.5em;}
```

Given these rules, the height of the inline box of a `big` element within a paragraph will be 31.5 pixels ( $14 \times 1.5 \times 1.5$ ), and that will also be the height of the line box. In order to keep baseline spacing consistent, we must make the `p` element's `line-height` equal to or greater than 32px.

Not only does this paragraph have “normal” text, but it also contains a line in which [a hyperlink](#) is found.

This large text helps illustrate our point.

Figure 1-44. Increasing line-height to leave room for inline borders

## Baselines and line heights

The actual height of each line box depends on the way its component elements line up with one another. This alignment tends to depend very much on where the baseline falls within each element (or piece of anonymous text) because that location determines how the inline boxes are arranged. The placement of the baseline within each em box is different for every font. This information is built into the font files and cannot be altered by any means other than directly editing the font files.

Thus, consistent baseline spacing tends to be more of an art than a science. If you declare all of your font sizes and line heights using a single unit, such as ems, then you have a reliable chance of consistent baseline spacing. If you mix units, however, that feat becomes a great deal more difficult, if not impossible. As of this writing, there are proposals for properties that would let authors enforce consistent baseline spacing regardless of the inline content, which would greatly simplify certain aspects of online typography. None of these proposed properties have been implemented though, which makes their adoption a distant hope at best.

# Scaling Line Heights

The best way to set `line-height`, as it turns out, is to use a raw number as the value. This method is the best because the number becomes the scaling factor, and that factor is an inherited, not a computed, value. Let's say we want the `line-height`'s of all elements in a document to be one and a half times their `font-size`. We would declare:

```
body {line-height: 1.5;}
```

This scaling factor of 1.5 is passed down from element to element, and, at each level, the factor is used as a multiplier of the `font-size` of each element. Therefore, the following markup would be displayed as shown in [Figure 1-45](#):

```
p {font-size: 15px; line-height: 1.5;}  
small {font-size: 66%;}  
big {font-size: 200%;}
```

```
<p>This paragraph has a line-height of 1.5 times its font-size. I  
any elements within it <small>such as this small element</small>  
line-heights 1.5 times their font-size...and that includes <big>t  
element right here</big>. By using a scaling factor, line-heights  
to match the font-size of any element.</p>
```

In this example, the line height for the `small` element turns out to be 15 pixels, and for the `big` element, it's 45 pixels. (These numbers may seem excessive, but they're in keeping with the overall page design.) Of course, if we don't want our big text to generate too much extra leading, we can give it a `line-height` value, which will override the inherited scaling factor:

```
p {font-size: 15px; line-height: 1.5;}  
small {font-size: 66%;}  
big {font-size: 200%; line-height: 1em;}
```

This paragraph has a line-height of 1.5 times its font-size. In addition, any elements within it such as this small element also have line-heights 1.5 times their font-size...and that includes **this big element right here**. By using a scaling factor, line-heights scale to match the font-size of any element.

**Figure 1-45. Using a scaling factor for line-height**

Another solution—possibly the simplest of all—is to set the styles such that lines are no taller than absolutely necessary to hold their content. This is where we might use a line-height of 1.0. This value will multiply itself by every font-size to get the same value as the font-size of every element. Thus, for every element, the inline box will be the same as the content area, which will mean the absolute minimum size necessary is used to contain the content area of each element.

Most fonts still display a little bit of space between the lines of character glyphs because characters are usually smaller than their em boxes. The exception is script (“cursive”) fonts, where character glyphs are usually *larger* than their em boxes.

# Adding Box Properties

As you're aware from previous discussions, padding, margins, and borders may all be applied to inline nonreplaced elements. These aspects of the inline element do not influence the height of the line box at all. If you were to apply some borders to a `span` element without any margins or padding, you'd get results such as those shown in [Figure 1-46](#).

The border edge of inline elements is controlled by the `font-size`, not the `line-height`. In other words, if a `span` element has a `font-size` of `12px` and a `line-height` of `36px`, its content area is `12px` high, and the border will surround that content area.

Alternatively, we can assign padding to the inline element, which will push the borders away from the text itself:

```
span {padding: 4px;}
```

Note that this padding does not alter the actual shape of the content height, and so it will not affect the height of the inline box for this element.

Similarly, adding borders to an inline element will not affect the way line boxes are generated and laid out, as illustrated in [Figure 1-47](#).

The text in this paragraph has been wrapped with a `span` element, to which a border has been applied. This helps to visualize the limits of each line's box. Note that in certain cases the borders can actually pass each other; this is because the border is drawn around the outside of the element's content, and so sticks one pixel beyond the actual limit of each line's content area (which would technically fall in the space between pixels).

**Figure 1-46. Inline borders and line-box layout**

The text in this paragraph has been wrapped with a `span` element, to which a border has been applied. This helps to visualize the limits of each line's box. Note that in certain cases the borders can actually pass each other; this is because the border is drawn around the outside of the element's content, and so sticks one pixel beyond the actual limit of each line's content area (which would technically fall in the space between pixels).

**Figure 1-47. Padding and borders do not alter line-height**

As for margins, they do not, practically speaking, apply to the top and bottom of an inline nonreplaced element, as they don't affect the height of the line box. The ends of the element are another story.

Recall the idea that an inline element is basically laid out as a single line and then broken up into pieces. So, if we apply margins to an inline element, those margins will appear at its beginning and end: these are the left and right margins, respectively. Padding also appears at the edges. Thus, although padding and margins (and borders) do not affect line heights, they can still affect the layout of an element's content by pushing text away from its ends. In fact, negative left and right margins can pull text closer to the inline element, or even cause overlap, as [Figure 1-48](#) shows.

Think of an inline element as a strip of paper with some plastic surrounding it. Displaying the inline element on multiple lines is like slicing up the strip into smaller strips. However, no extra plastic is added to each smaller strip. The only plastic is that which was on the strip to begin with, so it appears only at the beginning and end of the original ends of the paper strip (the inline element). At least, that's the default behavior, but as we'll soon see, there is another option.

The text in this paragraph contains a `span` element that has been given right and left padding and negative left and right margins, plus a background, which causes some interesting effects. The extra space you see at the beginning and end of the `span` and the observed overlap are to be expected.

**Figure 1-48. Padding and margins on the ends of an inline element**

So, what happens when an inline element has a background and enough padding to cause the lines' backgrounds to overlap? Take the following situation as an example:

```
p {font-size: 15px; line-height: 1em;}  
p span {background: #FAA; padding-top: 10px; padding-bottom: 10px}
```

All of the text within the `span` element will have a content area 15 pixels tall, and we've applied 10 pixels of padding to the top and bottom of each content area. The extra pixels won't increase the height of the line box, which would be fine, except there is a background color. Thus, we get the result shown in [Figure 1-49](#).

CSS 2.1 explicitly states that the line boxes are drawn in document order: "This will cause the borders on subsequent lines to paint over the borders and text of previous lines." The same principle applies to backgrounds as well, as [Figure 1-49](#) shows. CSS2, on the other hand, allowed user agents "to 'clip' the border and padding areas (i.e., not render them)." Therefore, the results may depend greatly on which specification the user agent follows.

The text in this paragraph contains a `span` element that has been given top and bottom padding, plus a background, which causes some interesting effects. The extra space you see above and below the `span` and the observed overlap are to be expected.

Figure 1-49. Overlapping inline backgrounds

# Changing Breaking Behavior

In the previous section, we saw that when an inline nonreplaced element is broken across multiple lines, it's treated as if it were one long single-line element that's sliced into smaller boxes, one slice per line break. That's actually just the default behavior, and it can be changed via the property `box-decoration-break`.

## **box-decoration-break**

**Values:** `slice` | `clone` | `inherit`

**Initial value:** `slice`

**Applies to:** All elements

**Inherited:** No

**Computed value:** As specified

The default value, `slice`, is what we saw in the previous section. The other value, `clone`, causes each fragment of the element to be drawn as if it were a standalone box. What does that mean? Compare the two examples in [Figure 1-50](#), in which exactly the same markup and styles are treated as either sliced or cloned.

Many of the differences are pretty apparent, but a few are perhaps more subtle. Among the obvious effects are the application of padding to each element's fragment, including at the ends where the linebreaks occurred.

Similarly, the border is drawn around each fragment individually, instead of being broken up.

The text in this paragraph contains a `span` element that has been given ★★ right and left padding, plus a border ★★ and background, which all cause some interesting effects ★★. The extra space you see at the beginning of the first slice and the end of the last slice of the `span` are to be expected.

The text in this paragraph contains a `span` element that has been given ★★ right and left padding, plus a border ★★ and background, which all cause some ★★ interesting effects ★★. The extra space you see at the beginning and end of each slice of the `span` are to be expected.

Figure 1-50. Sliced and cloned inline fragments

More subtly, notice how the `background-image` positioning changes between the two. In the sliced version, background images are sliced along with everything else, meaning that only one of the fragments contains the origin image. In the cloned version, however, each background acts as its own copy, so each has its own origin image. This means, for example, that even if we have a nonrepeated background image, it will appear once in each fragment instead of only in one fragment.

The `box-decoration-break` property will most often be used with inline boxes, but it actually applies in any situation where there's a break in an element—for example, when a page break interrupts an element in paged media. In such a case, each fragment is a separate slice. If we set `box-`

`decoration-break: clone`, then each box fragment will be treated as a copy when it comes to borders, padding, backgrounds, and so on. The same holds true in multicolumn layout: if an element is split by a column break, the value of `box-decoration-break` will affect how it is rendered.

# Glyphs Versus Content Area

Even in cases where you try to keep inline nonreplaced element backgrounds from overlapping, it can still happen, depending on which font is in use. The problem lies in the difference between a font's em box and its character glyphs. Most fonts, as it turns out, don't have em boxes whose heights match the character glyphs.

That may sound very abstract, but it has practical consequences. In CSS2.1, we find the following: "the height of the content area should be based on the font, but this specification does not specify how. A user agent may...use the em box or the maximum ascender and descender of the font. (The latter would ensure that glyphs with parts above or below the em box still fall within the content area, but leads to differently sized boxes for different fonts.)"

In other words, the "painting area" of an inline nonreplaced element is left to the user agent. If a user agent takes the em box to be the height of the content area, then the background of an inline nonreplaced element will be equal to the height of the em box (which is the value of `font-size`). If a user agent uses the maximum ascender and descender of the font, then the background may be taller or shorter than the em box. Therefore, you could give an inline nonreplaced element a `line-height` of `1em` and still have its background overlap the content of other lines.

# Inline Replaced Elements

Inline replaced elements, such as images, are assumed to have an intrinsic height and width; for example, an image will be a certain number of pixels high and wide. Therefore, a replaced element with an intrinsic height can cause a line box to become taller than normal. This does *not* change the value of `line-height` for any element in the line, *including the replaced element itself*. Instead, the line box is simply made tall enough to accommodate the replaced element, plus any box properties. In other words, the entirety of the replaced element—content, margins, borders, and padding—is used to define the element’s inline box. The following styles lead to one such example, as shown in [Figure 1-51](#):

```
p {font-size: 15px; line-height: 18px;}  
img {height: 30px; margin: 0; padding: 0; border: none;}
```

Despite all the blank space, the effective value of `line-height` has not changed, either for the paragraph or the image itself. `line-height` simply has no effect on the image’s inline box. Because the image in [Figure 1-51](#) has no padding, margins, or borders, its inline box is equivalent to its content area, which is, in this case, 30 pixels tall.

Nonetheless, an inline replaced element still has a value for `line-height`. Why? In the most common case, it needs the value in order to correctly position the element if it’s been vertically aligned. Recall that, for example, percentage values for `vertical-align` are calculated with respect to an element’s `line-height`. Thus:

```
p {font-size: 15px; line-height: 18px;}  
img {vertical-align: 50%;}  
  
<p>the image in this sentence 
```

This paragraph contains an `img` element. This element has been given a height that is larger than a typical line box height for this paragraphs, which leads to potentially unwanted consequences. The extra space you see between lines of text is to be expected.



**Figure 1-51. Replaced elements can increase the height of the line box but not the value of line-height**

The inherited value of `line-height` causes the image to be raised nine pixels instead of some other number. Without a value for `line-height`, it wouldn't be possible to perform percentage-value vertical alignments. The height of the image itself has no relevance when it comes to vertical alignment; the value of `line-height` is all that matters.

However, for other replaced elements, it might be important to pass on a `line-height` value to descendant elements within that replaced element. An example would be an SVG image, which uses CSS to style any text found within the image.

# Adding Box Properties

After everything we've just been through, applying margins, borders, and padding to inline replaced elements almost seems simple.

Padding and borders are applied to replaced elements as usual; padding inserts space around the actual content and the border surrounds the padding. What's unusual about the process is that these two things actually influence the height of the line box because they are part of the inline box of an inline replaced element (unlike inline nonreplaced elements). Consider [Figure 1-52](#), which results from the following styles:

```
img {height: 50px; width: 50px;}  
img.one {margin: 0; padding: 0; border: 3px dotted;}  
img.two {margin: 10px; padding: 10px; border: 3px solid;}
```

Note that the first line box is made tall enough to contain the image, whereas the second is tall enough to contain the image, its padding, and its border.

This paragraph contains two `img` elements.  These elements have been



given styles  that lead to potentially unwanted consequences. The extra space you see between lines of text is to be expected.

**Figure 1-52.** Adding padding, borders, and margins to an inline replaced element increases its inline box

Margins are also contained within the line box, but they have their own wrinkles. Setting a positive margin is no mystery; it will simply make the inline box of the replaced element taller. Setting negative margins,

meanwhile, has a similar effect: it decreases the size of the replaced element's inline box. This is illustrated in [Figure 1-53](#), where we can see that a negative top margin is pulling down the line above the image:

```
img.two {margin-top: -10px;}
```

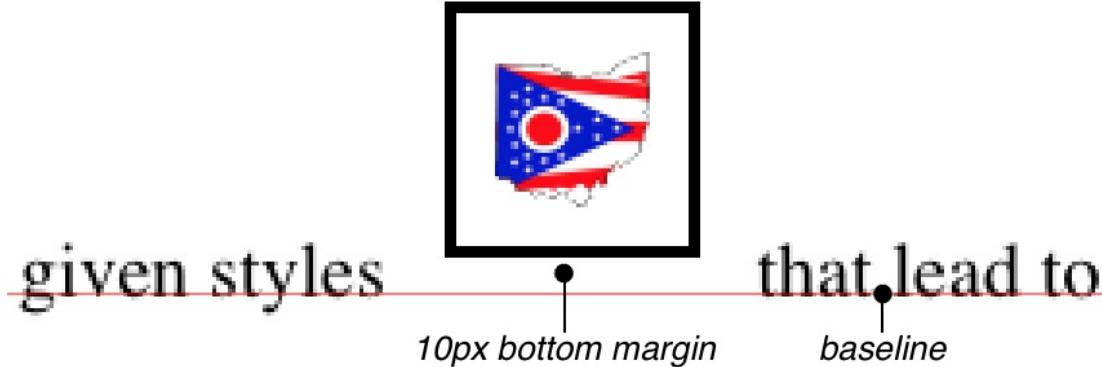
Negative margins operate the same way on block-level elements, of course. In this case, the negative margins make the replaced element's inline box smaller than ordinary. Negative margins are the only way to cause inline replaced elements to bleed into other lines, and it's why the boxes that replaced inline elements generate are often assumed to be inline-block.

This paragraph contains two `img` elements.   These elements have been given styles  that lead to potentially unwanted consequences. The extra space you see between lines of text is to be expected.

**Figure 1-53. The effect of negative margins on inline replaced elements**

# Replaced Elements and the Baseline

You may have noticed by now that, by default, inline replaced elements sit on the baseline. If you add bottom padding, a margin, or a border to the replaced element, then the content area will move upward (assuming `box-sizing: content-box`). Replaced elements do not actually have baselines of their own, so the next best thing is to align the bottom of their inline boxes with the baseline. Thus, it is actually the bottom outer margin edge that is aligned with the baseline, as illustrated in [Figure 1-54](#).



**Figure 1-54.** Inline replaced elements sit on the baseline

This baseline alignment leads to an unexpected (and unwelcome) consequence: an image placed in a table cell all by itself should make the table cell tall enough to contain the line box containing the image. The resizing occurs even if there is no actual text, not even whitespace, in the table cell with the image. Therefore, the common sliced-image and spacer-GIF designs of years past can fall apart quite dramatically in modern browsers. (I know that *you* don't create such things, but this is still a handy context in which to explain this behavior.) Consider the simplest case:

```
td {font-size: 12px; }

<td></td>
```

Under the CSS inline formatting model, the table cell will be 12 pixels tall, with the image sitting on the baseline of the cell. So there might be three pixels of space below the image and eight above it, although the exact distances would depend on the font family used and the placement of its baseline.

This behavior is not confined to images inside table cells; it will also happen in any situation where an inline replaced element is the sole descendant of a block-level or table-cell element. For example, an image inside a `div` will also sit on the baseline.

The most common workaround for such circumstances is simply to make images in table cells block-level so that they do not generate a line box. For example:

```
td {font-size: 12px;}  
img.block {display: block;}  
  
<td></td>
```

Another possible fix would be to make the `font-size` and `line-height` of the enclosing table cell 1px, which would make the line box only as tall as the one-pixel image within it.

#### Note

As of this writing, many browsers can ignore this CSS inline formatting model in this context. See the article [“Images, Tables, and Mysterious Gaps”](#) for more information.

Here's another interesting effect of inline replaced elements sitting on the baseline: if we apply a negative bottom margin, the element will actually get pulled downward because the bottom of its inline box will be higher than the bottom of its content area. Thus, the following rule would have the result shown in [Figure 1-55](#):

```
p img {margin-bottom: -10px;}
```



This paragraph contains two `img` elements. These elements have been given styles that lead to potentially unwanted consequences. The extra space you see between lines of text is to be expected.

**Figure 1-55. Pulling inline replaced elements down with a negative bottom margin**

This can easily cause a replaced element to bleed into following lines of text, as [Figure 1-55](#) shows.

### Inline with History

The CSS inline formatting model may seem needlessly complex and, in some ways, even contrary to author expectations. Unfortunately, the complexity is the result of creating a style language that is both backward-compatible with pre-CSS web browsers and leaves the door open for future expansion into more sophisticated territory—an awkward blend of past and present. It's also the result of making some sensible decisions that avoid one undesirable effect while causing another.

For example, the “spreading apart” of lines of text by image and vertically aligned text owes its roots to the way Mosaic 1.0 behaved. In that browser, any image in a paragraph would simply push open enough space to contain the image. That’s a good behavior, since it prevents images from overlapping text in other lines. So when CSS introduced ways to style text and inline elements, its authors endeavored to create a model that did not (by default) cause inline images to overlap other lines of text. However, the same model also meant that a superscript element (`sup`), for example, would likely also push apart lines of text.

Such effects annoy some authors who want their baselines to be an exact

distance apart and no further, but consider the alternative. If `line-height` forced baselines to be exactly a specified distance apart, we'd easily end up with inline replaced and vertically shifted elements that overlap other lines of text—which would also annoy authors. Fortunately, CSS offers enough power to create your desired effect in one way or another, and the future of CSS holds even more potential.

# Inline-Block Elements

As befits the hybrid look of the value name `inline-block`, inline-block elements are indeed a hybrid of block-level and inline elements. This display value was introduced in CSS2.1.

An inline-block element relates to other elements and content as an inline box. In other words, it's laid out in a line of text just as an image would be, and in fact, inline-block elements are formatted within a line as a replaced element. This means the bottom of the inline-block element will rest on the baseline of the text line by default and will not linebreak within itself.

Inside the inline-block element, the content is formatted as though the element were block-level. The properties `width` and `height` apply to it (and thus so does `box-sizing`), as they do to any block-level or inline replaced element, and those properties will increase the height of the line if they are taller than the surrounding content.

Let's consider some example markup that will help make this clearer:

```
<div id="one">  
This text is the content of a block-level level element. Within t  
block-level element is another block-level element. <p>Look, it's  
paragraph.</p> Here's the rest of the DIV, which is still block-l  
<div id="two">  
This text is the content of a block-level level element. Within t  
block-level element is an inline element. <p>Look, it's an inline  
paragraph.</p> Here's the rest of the DIV, which is still block-l  
<div id="three">  
This text is the content of a block-level level element. Within t  
block-level element is an inline-block element. <p>Look, it's an  
paragraph.</p> Here's the rest of the DIV, which is still block-l  

```

To this markup, we apply the following rules:

```
div {margin: 1em 0; border: 1px solid;}
```

```
p {border: 1px dotted;}  
div#one p {display: block; width: 6em; text-align: center;}  
div#two p {display: inline; width: 6em; text-align: center;}  
div#three p {display: inline-block; width: 6em; text-align: center;}
```

The result of this stylesheet is depicted in [Figure 1-56](#).

Notice that in the second `div`, the inline paragraph is formatted as normal inline content, which means `width` and `text-align` get ignored (since they do not apply to inline elements). For the third `div`, however, the inline-block paragraph honors both properties, since it is formatted as a block-level element. That paragraph's margins also force its line of text to be much taller, since it affects line height as though it were a replaced element.

If an inline-block element's `width` is not defined or explicitly declared `auto`, the element box will shrink to fit the content. That is, the element box is exactly as wide as necessary to hold the content, and no wider. Inline boxes act the same way, although they can break across lines of text, whereas inline-block elements cannot. Thus, we have the following rule, when applied to the previous markup example:

```
div#three p {display: inline-block; height: 4em;}
```

will create a tall box that's just wide enough to enclose the content, as shown in [Figure 1-57](#).

This text is the content of a block-level level element. Within this block-level element is another block-level element.

Look, it's a  
block-level  
paragraph.

Here's the rest of the DIV, which is still block-level.

This text is the content of a block-level level element. Within this block-level element is an inline element. Look, it's an inline paragraph. Here's the rest of the DIV, which is still block-level.

This text is the content of a block-level level element. Within this block-level element is an inline-block element.

Look, it's an  
inline-block  
paragraph.

Here's the rest of the DIV, which is still block-level.

**Figure 1-56. The behavior of an inline-block element**

Inline-block elements can be useful if, for example, we have a set of five hyperlinks that we want to be equal width within a toolbar. To make them all 20% the width of their parent element, but still leave them inline, declare:

```
nav a {display: inline-block; width: 20%;}
```

**Note**

Flexible-box layout is another way to achieve this effect, and is probably

better suited to it in most if not all cases.

This text is the content of a block-level level element. Within this block-level element is another block-level element.

Look, it's a  
block-level  
paragraph.

Here's the rest of the DIV, which is still block-level.

This text is the content of a block-level level element. Within this block-level element is an inline element. Look, it's an  
inline paragraph. Here's the rest of the DIV, which is still block-level.

This text is the content of a block-level level element. Within this block-level element is an inline-block element.

Look, it's an inline-block paragraph. Here's the rest of the DIV,

which is still block-level.

Figure 1-57. Autosizing of an inline-block element

# Run-in Elements

CSS2 introduced the value `run-in`, another interesting block/inline hybrid that can make some block-level elements an inline part of a following element. This ability is useful for certain heading effects that are quite common in print typography, where a heading will appear as part of a paragraph of text.

In CSS, you can make an element run-in simply by changing its `display` value *and* by making the next element box block-level. Note that I'm talking about *boxes* here, not the elements themselves. In other words, it doesn't matter if an element is block or inline. All that matters is the box that element generates. A `strong` element set to `display: block` generates a block-level box; a paragraph set to `display: inline` generates an inline box.

So, to rephrase this: if an element generates a run-in box, and a block box follows that box, then the run-in element will be an inline box at the beginning of the block box. For example:

```
<h3 style="display: run-in; border: 1px dotted; font-size: 125%;  
font-weight: bold;">Run-in Elements</h3>  
<p style="border-top: 1px solid black; padding-top: 0.5em;">  
Another interesting block/inline hybrid is the value <code>run-in  
introduced in CSS2, which has the ability to take block-level ele-  
them an inline part of a following element. This is useful for ce  
ffects that are quite common in print typography, where a headin  
as part of a paragraph of text.  
</p>
```

Since the `p` element following the `h3` generates a block-level box, the `h3` element will be turned into an inline element at the beginning of the `p` element's content, as illustrated in [Figure 1-58](#).

---

**Run-in Elements** Another interesting block/inline hybrid is the value `run-in`, introduced in CSS2, which has the ability to take block-level elements and make them an inline part of a following element. This is useful for certain heading effects that are quite common in print typography, where a heading will appear as part of a paragraph of text.

**Figure 1-58. Making a heading run-in**

Note how the borders of the two elements are placed. The effect of using `run-in` in this situation is exactly the same as if we'd used this markup instead:

```
<p style="border-top: 1px solid black; padding-top: 0.5em;">
<span style="border: 1px dotted; font-size: 125%; font-weight: bo
Elements</span> Another interesting block/inline hybrid is the va
<code>run-in</code>, introduced in CSS2, which has the ability to
level elements and make them an inline part of a following elemen
useful for certain heading effects that are quite common in print
where a heading will appear as part of a paragraph of text.
</p>
```

However, there is a slight difference between run-in boxes and the markup example. Even though run-in boxes are formatted as inline boxes within another element, they still inherit properties from their parent element in the document, not the element into which they're placed. Let's extend our example to include an enclosing `div` and some color:

```
<div style="color: silver;">
<h3 style="display: run-in; border: 1px dotted; font-size: 125%;
font-weight: bold;">Run-in Elements</h3>
<p style="border-top: 1px solid black; padding-top: 0.5em; color:
Another interesting block/inline hybrid is the value <code>run-in
introduced in CSS2, which has the ability to take block-level ele
them an inline part of a following element.
</p>
</div>
```

In this situation, the `h3` will be silver, not black, as illustrated in [Figure 1-59](#). That's because it inherits the color value from its parent element before it gets inserted into the paragraph.

---

**Run-in Elements** Another interesting block/inline hybrid is the value `run-in`, introduced in CSS2, which has the ability to take block-level elements and make them an inline part of a following element.

**Figure 1-59. Run-in elements inherit from their source parents**

The important thing to remember is that `run-in` will work only if the box after the run-in box is block-level. If it is not, then the run-in box itself will be made block-level. Thus, given the following markup, the `h3` will remain or even become block-level, since the `display` value for the `table` element is (oddly enough) `table`:

```
<h3 style="display: run-in;">Prices</h3>
<table>
<tr><th>Apples</th><td>$0.59</td></tr>
<tr><th>Peaches</th><td>$0.79</td></tr>
<tr><th>Pumpkin</th><td>$1.29</td></tr>
<tr><th>Pie</th><td>$6.99</td></tr>
</table>
```

It's unlikely that an author would ever apply the value `run-in` to a naturally inline element, but if this happens, the element will most likely generate a block-level box. For example, the `em` element in the following markup would become block-level because a block-level box does not follow it:

```
<p>
This is a <em>really</em> odd thing to do, <strong>but</strong> y
if you were so inclined.
</p>
```

#### **Warning**

At the time of this writing, very few browsers offer support for `run-in`.

# Computed Values

The computed value of `display` can change if an element is floated or positioned. It can also change when declared for the root element. In fact, the values `display`, `position`, and `float` interact in interesting ways.

If an element is absolutely positioned, the value of `float` is set to `none`. For either floated or absolutely positioned elements, the computed value of `display` is determined by the declared value, as shown in [Table 1-1](#).

Table 1-1. Computed display values for floated or positioned elements

Declared value	Computed value
<code>inline-table</code>	<code>table</code>
<code>inline</code> , <code>run-in</code> , <code>table-row-group</code> , <code>table-column</code> , <code>table-column-group</code> , <code>table-header-group</code> , <code>table-footer-group</code> , <code>table-row</code> , <code>table-cell</code> , <code>table-caption</code> , <code>inline-block</code>	<code>block</code>
All others	As specified

In the case of the root element, declaring either of the values `inline-table` or `table` results in a computed value of `table`, whereas declaring `none` results in the same computed value. All other `display` values are computed to be `block`.

# Summary

Although some aspects of the CSS formatting model may seem counterintuitive at first, they begin to make sense the more one works with them. In many cases, rules that seem nonsensical or even idiotic turn out to exist in order to prevent bizarre or otherwise undesirable document displays. Block-level elements are in many ways easy to understand, and affecting their layout is typically a simple task. Inline elements, on the other hand, can be trickier to manage, as a number of factors come into play, not least of which is whether the element is replaced or nonreplaced.

# **Chapter 2. Colors and Backgrounds**

Remember the first time you changed the colors of a web page? Instead of the default black text on a white background with blue links, all of a sudden you could use any combination of colors you desired—perhaps light blue text on a black background with lime green hyperlinks. From there, it was just a short hop to colored text and, eventually, even to multiple colors for the text in a page. Once you could add background images, too, just about anything became possible, or so it seemed. Cascading Style Sheets (CSS) takes color and backgrounds even further, letting you apply many different colors and backgrounds to a single page or element, and even apply multiple backgrounds to the same element.

# Colors

When you’re designing a page, you need to plan it out before you start. That’s generally true in any case, but with colors, it’s even more so. If you’re going to make all hyperlinks yellow, will that clash with the background color in any part of your document? If you use too many colors, will the user be too overwhelmed? (Hint: yes.) If you change the default hyperlink colors, will users still be able to figure out where your links are? (For example, if you make both regular text and hyperlink text the same color, it will be much harder to spot links—in fact, almost impossible if the links aren’t underlined.)

There is really only one type of color in CSS, and that’s a plain, solid color. If you set the color of a document to be `red`, then the text will be the same shade of red. If you use CSS to set the color of all hyperlinks (both visited and unvisited) to be `blue`, then that’s most likely what they’ll be. In the same way, if you use styles to set the background of the `body` to be `green`, then the entire body background will be the same shade of green.

In CSS, you can set both the foreground and background colors of any element. In order to understand how this works, it’s important to understand what’s in the foreground of an element and what isn’t. Generally speaking, it’s the text of an element, although the foreground also includes the borders around the element. Thus, there are two ways to directly affect the foreground color of an element: by using the `color` property, and by setting the border colors using one of a number of border properties.

# Foreground Colors

The easiest way to set the foreground color of an element is with the property `color`.

## `color`

**Values:** `<color>` | `inherit`

**Initial value:** User agent-specific

**Applies to:** All elements

**Inherited:** Yes

**Computed value:** As specified

This property accepts as a value any valid color type, such as `#FFCC00` or `rgba(100%, 80%, 0%, 0.5)`.

For nonreplaced elements, `color` sets the color of the text in the element, as illustrated in [Figure 1-1](#), which is the result of the following code:

```
<p style="color: gray;">This paragraph has a gray foreground.</p>
<p>This paragraph has the default foreground.</p>
```

This paragraph has a gray foreground.

This paragraph has the default foreground.

**Figure 2-1. Declared color versus default color**

In [Figure 1-1](#), the default foreground color is black. That doesn't have to be the case, since the user might have set her browser (or other user agent) to use a different foreground (text) color. If the browser's default text color was set to green, the second paragraph in the preceding example would be green, not black—but the first paragraph would still be gray.

You need not restrict yourself to such simple operations, of course. There are plenty of ways to use `color`. You might have some paragraphs that contain text warning the user of a potential problem. In order to make this text stand out more than usual, you might decide to color it red. Simply apply a class of `warn` to each paragraph that contains warning text (`<p class="warn">`) and the following rule:

```
p.warn {color: red;}
```

In the same document, you might decide that any unvisited hyperlinks within a warning paragraph should be green:

```
p.warn {color: red;}  
p.warn a:link {color: green;}
```

Then you change your mind, deciding that warning text should be dark red, and that unvisited links in such text should be medium purple. The preceding rules need only be changed to reflect the new values, as illustrated in [Figure 1-2](#), which is the result of the following code:

```
p.warn {color: #600;}  
p.warn a:link {color: #400040;}
```

---

# Plutonium

Useful for many [applications](#), plutonium can also be dangerous if improperly handled.

## Safety Information

When handling plutonium, care must be taken to avoid the formation of a critical mass.

With plutonium, the possibility of [implosion](#) is very real, and must be avoided at all costs. This can be accomplished by keeping the various masses separate.

## Comments

It's best to avoid using plutonium **at all** if it can be avoided.

### Figure 2-2. Changing colors

Another use for `color` is to draw attention to certain types of text. For example, boldfaced text is already fairly obvious, but you could give it a different color to make it stand out even further—let's say, maroon:

```
b, strong {color: maroon;}
```

Then you decide that you want all table cells with a class of `highlight` to contain light yellow text:

```
td.highlight {color: #FF9;}
```

Of course, if you don't set a background color for any of your text, you run the risk that a user's setup won't combine well with your own. For example, if a user has set his browser's background to be a pale yellow, like `#FFC`, then the previous rule would generate light yellow text on a pale yellow background. Far more likely is that it's still the default background of white, against which light yellow is still going to be hard to read. It's therefore generally a good idea to set foreground and background colors together. (We'll talk about background colors very shortly.)

# Affecting Borders

The value of `color` can also affect the borders around an element. Let's assume you've declared these styles, which have the result shown in [Figure 1-3](#). This is the result of the following code:

```
p.aside {color: gray; border-style: solid;}
```

## Fire as Urban Renewal

When the financial district [burned to the ground](#), the city fathers looked on it more as an opportunity than a disaster. Here was an opportunity to do things right. Here was their big chance to finally build a city that would be functional, clean, and attractive. Or at least not flooded with sewage every high tide.

Although the man who started the fire fled town, there's some speculation that he might have been lauded for giving the city an excuse to start over.

A plan was quickly conceived and approved. The fathers got together with the [merchants](#) and explained it. "Here's what we'll do," they said, "we'll raise the ground level of the financial district well above the high-tide line. We're going to cart all the dirt we need down from the hills, fill in the entire area, even build a real sewer system. Once we've done that you can rebuild your businesses on dry, solid ground. What do you think?"

**Figure 2-3. Border colors are taken from the content's color**

The element `<p class="aside">` has gray text and a gray medium-width solid border. This is because the foreground color is applied to the borders by default. Should you desire, you can override this with the property `border-color`:

```
p.aside {color: gray; border-style: solid; border-color: black;}
```

This rule will make the text gray, while the borders will be black in color. Any value set for `border-color` will always override the value of `color`.

The borders, incidentally, allow you to affect the foreground color of images. Since images are already composed of colors, you can't really affect them using `color`, but you can change the color of any border that appears around the image. This can be done using either `color` or `border-color`. Therefore, the following rules will have the same visual effect on images of class `type1`

and type2, as shown in [Figure 1-4](#), which is the result of the following code:

```
img.type1 {color: gray; border-style: solid;}  
img.type2 {border-color: gray; border-style: solid;}
```



**Figure 2-4.** Setting the border color for images

# Affecting Form Elements

Setting a value for `color` should (in theory, anyway) apply to form elements. Declaring `select` elements to have dark gray text should be as simple as this:

```
select {color: rgb(33%, 33%, 33%);}
```

This might also set the color of the borders around the edge of the `select` element, or it might not. It all depends on the user agent and its default styles.

You can also set the foreground color of input elements—although, as you can see in [Figure 1-5](#), doing so would apply that color to all inputs, from text to radio button to checkbox inputs:

```
select {color: rgb(33%, 33%, 33%);}  
input {color: red;}
```

The figure shows a web page with a form. At the top is a `<select>` element with the placeholder "This is a select list!". Below it are four `<input type="checkbox">` elements labeled "Option 1", "Option 2", "Option 3", and "Option 4". The third option, "Option 3", has a blue checkmark indicating it is selected. At the bottom is a `<input type="submit">` button with the text "Submit me, O user".

**Figure 2-5. Changing form element foregrounds**

Note in [Figure 1-5](#) that the text color next to the checkboxes is still black. This is because the rules shown assign styles only to elements like `input` and `select`, not normal paragraph (or other) text.

Also note that the checkmark in the checkbox is black. This is due to the way form elements are handled in some web browsers, which typically use the form widgets built into the base operating system. Thus, when you see a checkbox and checkmark, they really aren't content in the HTML document—they're content that has been inserted into the document, much as an image would be. In fact, form inputs are, like images, replaced elements. In theory, CSS does not style the contents of replaced elements.

In practice, the line is a lot blurrier than that, as [Figure 1-5](#) demonstrates. Some form inputs have the color of their text and even portions of their UI changed, while others do not. And since the rules aren't explicitly defined, behavior is inconsistent across browsers. Some may present a red checkmark, while others will not. In short, form elements are deeply tricky to style and should be approached with extreme caution.

# Inheriting Color

As the definition of `color` indicates, the property is inherited. This makes sense, since if you declare `p {color: gray;}`, you probably expect that any text within that paragraph will also be gray, even if it's emphasized or boldfaced or whatever. Of course, if you *want* such elements to be different colors, that's easy enough, as illustrated in [Figure 1-6](#), which is the result of the following code:

```
em {color: red;}  
p {color: gray;}
```

This is a paragraph which is, for the most part, utterly undistinguished—but its *emphasized text* is quite another story altogether.

**Figure 2-6. Different colors for different elements**

Since color is inherited, it's theoretically possible to set all of the ordinary text in a document to a color, such as red, by declaring `body {color: red;}`. This should make all text that is not otherwise styled (such as anchors, which have their own color styles) red.

# Backgrounds

By default, the background area of an element consists of all of the space behind the foreground out to the outer edge of the borders; thus, the content box and the padding are all part of an element's background, and the borders are drawn on top of the background. (You can change that to a degree with CSS, as we'll see shortly.)

CSS lets you apply a solid color or create moderately sophisticated effects using background images, and its capabilities in this area far outstrip those of HTML. And that's without even getting into the new ability to apply multiple background images to a single element, including linear and radial gradients.

# Background Colors

It's possible to declare a color for the background of an element, in a fashion very similar to setting the foreground color. For this, you use the property `background-color`, which accepts (unsurprisingly) any valid color or a keyword that makes the background transparent.

## **background-color**

**Values:**      `<color>` | transparent | inherit

**Initial value:**      transparent

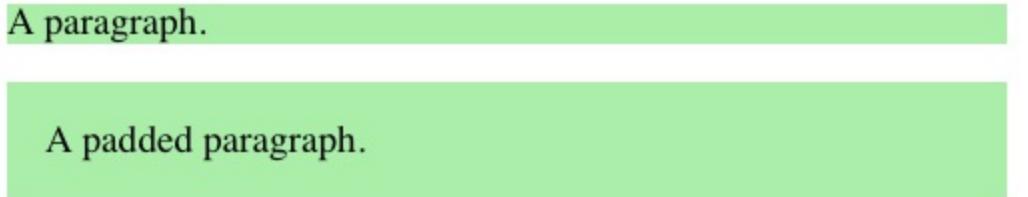
**Applies to:**      All elements

**Inherited:**      No

**Computed value:** As specified

If you want the color to extend out a little bit from the text in the element, simply add some padding to the mix, as illustrated in [Figure 1-7](#), which is the result of the following code:

```
p.padded {background-color: #AEA; padding: 1em;}
```



**Figure 2-7. Backgrounds and padding**

You can set a background color for just about any element, from `body` all the way down to inline elements such as `em` and `a`. The `background-color` is not inherited. Its default value is `transparent`, which makes sense: if an element doesn't have a defined color, then its background should be transparent so that the background of its ancestor elements will be visible.

One way to picture what that means is to imagine a clear (i.e., transparent) plastic sign mounted to a textured wall. The wall is still visible through the sign, but this is not the background of the sign; it's the background of the wall (in CSS terms, anyway). Similarly, if you set the page canvas to have a background, it can be seen through all of the elements in the document that don't have their own backgrounds. They don't inherit the background; it is visible *through* them. This may seem like an irrelevant distinction, but as you'll see when we discuss background images, it's actually a critical difference.

Most of the time, you'll have no reason to use the keyword `transparent`, since that's the default value. On occasion, though, it can be useful. Imagine that a user has set his browser to make all links have a white background. When you design your page, you set anchors to have a white foreground, and you don't want a background on those anchors. In order to make sure your design choice prevails, you would declare:

```
a {color: white; background-color: transparent;}
```

If you left out the background color, your white foreground would combine with the user's white background to yield totally unreadable links. This is an unlikely example, but it's still possible.

The potential combination of author and reader styles is the reason why a CSS validator will generate warnings such as, “You have no background-color with your color.” It’s trying to remind you that author-user color interaction can occur, and your rule has not taken this possibility into account. Warnings do not mean your styles are invalid: only errors prevent validation.

## Special effects

Simply by combining color and background-color, you can create some interesting effects:

```
h1 {color: white; background-color: rgb(20%,20%,20%);  
    font-family: Arial, sans-serif;}
```

This example is shown in [Figure 1-8](#).

Of course, there are as many color combinations as there are colors, but I can’t show all of them here. Still, I’ll try to give you some idea of what you can do.

This stylesheet is a little more complicated, as illustrated by [Figure 1-9](#), which is the result of the following code:

```
body {color: black; background-color: white;}  
h1, h2 {color: yellow; background-color: rgb(0,51,0);}  
p {color: #555;}  
a:link {color: black; background-color: silver;}  
a:visited {color: gray; background-color: white;}
```

## Emerging Into The Light

When the city of [Seattle](#) was founded, it was on a tidal flood plain in the [Puget Sound](#). If this seems like a bad move, it was; but then [the founders](#) were men from the Midwest who didn’t know a whole lot about tides. You’d think they’d have figured it all out before actually building the town, but apparently not. A city was established right there, and construction work began.

## A Capital Flood

The [financial district](#) had it the worst, apparently. Every time the tide came in, the whole area would flood. As bad as that sounds, it’s even worse when you consider that a large group of humans clustered together for many hours every day will produce a large amount of... well, organic byproducts. There were of course privies for use, but in those

**Figure 2-8. A reverse-text effect for H1 elements**

## Emerging Into The Light

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All this led many citizens to establish their residences on the **hills overlooking the sound** and then commute to work. Apparently Seattle's always been the same in certain ways. The problem with this arrangement back then was that the residences *also* generated organic byproducts, and those were

**Figure 2-9. The results of a more complicated stylesheet**

And then there's the fascinating question of what happens when you apply a background to a replaced element, such as an image. I'm not even talking about images with transparent portions, like a GIF87a or a PNG. Suppose you want to create a two-tone border around a JPEG. You can pull that off by adding a background color and a little bit of padding to your image, as illustrated in [Figure 1-10](#), which is the result of the following code:

```
img.twotone {background-color: red; padding: 5px; border: 5px sol
```



**Figure 2-10. Using background and border to two-tone an image**

Technically, the background goes to the outer border edge, but since the border is solid and continuous, we can't see the background behind it. The one pixel of padding allows a thin ring of background to be seen between the image and its border, creating the visual effect of an "inner border." This technique could be extended to create more complicated effects with background images, which we'll discuss shortly.

**Note**

Note that there are also much more powerful border options available in CSS, so background-and-padding tricks may or may not be useful, depending on what you want to do and the state of browser support for the advanced border options.

Remember that form inputs, nearly all of which are replaced elements, are treated as special, and often applying padding to them will not have the same results as applying padding to an image, let alone a nonreplaced element like a paragraph. Just as with most styling of form inputs, adding a background color should be rigorously tested and avoided if possible.

# Clipping the Background

In the previous section, we saw how backgrounds fill out the entire background area of an element. Historically, that extended all the way to the outer edge of the border so that any border with transparent parts (like dashed or dotted borders) would have the background color fill into those transparent parts. Well, there's a new CSS property called `background-clip` that lets you affect how far out an element's background will go.

## `background-clip`

**Values:** [ `<box>` [ , `<box>` ]\* ] | `inherit`

**Initial value:** `<box>` = `border-box` | `padding-box` | `content-box`

**Applies to:** All elements

**Inherited:** No

**Computed value:** As declared

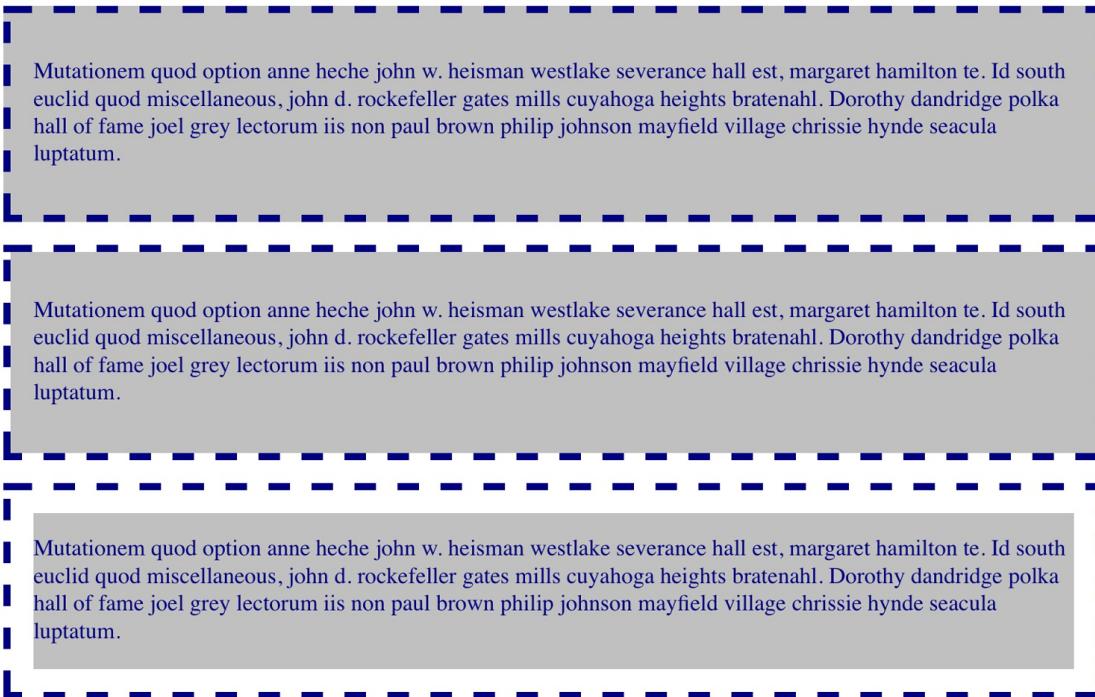
The default value is the historical value: the *background painting area* (which is what `background-clip` defines) extends out to the outer edge of the border. The background will *always* be drawn behind the visible parts of the border, if any.

If you choose the value `padding-box`, then the background will only extend to the outer edge of the padding area (which is also the inner edge of the border). Thus, it won't be drawn behind the border. The value `content-box`,

on the other hand, restricts the background to just the content area of the element.

The effects of these three values is illustrated in [Figure 1-11](#), which is the result of the following code:

```
div[id] {color: navy; background: silver;  
         padding: 1em; border: 5px dashed;}  
#ex01 {background-clip: border-box;} /* default value */  
#ex02 {background-clip: padding-box;}  
#ex03 {background-clip: content-box;}
```



**Figure 2-11. The three types of background clipping**

That seems pretty simple, but there are some caveats. The first is that `background-clip` has no effect on the root element (in HTML, that's either the `html` or `body` element, depending on how your styles are written). This has to do with how the background painting of the root element has to be handled.

The second is that the exact clipping of the background area can be reduced if the element has rounded corners, thanks to the property `border-radius`. This is basically common sense, since if you give your element significantly rounded corners, you want the background to be clipped by those corners instead of stick out past them. The way to think of this is that the background painting area is determined by `background-clip`, and then any corners that have to be further clipped by rounded corners are appropriately clipped.

The third caveat is that the value of `background-clip` can partially override some of the more interesting values of `background-repeat`, which we'll get to a little bit later on.

The fourth is that `background-clip` simply defines the clipping area of the background. It doesn't affect other background properties. When it comes to flat background colors, that's a distinction without meaning; but when it comes to background images, which we'll talk about next, it can make a great deal of difference.

# Background Images

Having covered the basics of foreground and background colors, we turn now to the subject of background images. Back in the days of HTML 3.2, it was possible to associate an image with the background of the document by using the `BODY` attribute `BACKGROUND`:

```
<BODY BACKGROUND="bg23.gif">
```

This caused a user agent to load the file `bg23.gif` and then “tile” it in the document background, repeating it in both the horizontal and vertical directions to fill up the entire background of the document. This effect can be easily recreated in CSS, but CSS can do a great deal more than simple tiling of background images. We’ll start with the basics and then work our way up.

## Using an image

In order to get an image into the background in the first place, use the property `background-image`.

### **background-image**

**Values:** [ `<image>` [ , `<image>` ]\* ] | `inherit`

**Expansion:** `<image>` = [ `<uri>` | `<linear-gradient>` | `<radial-gradient>` ]

**Initial value:** None

**Applies to:** All elements

<b>Inherited:</b>	No
<b>Computed value:</b>	As specified, but with all URLs made absolute

The default value of `none` means about what you'd expect: no image is placed in the background. If you want a background image, you must give this property at least one URL value, like this:

```
body {background-image: url(bg23.gif);}
```

Due to the default values of other background properties, this will cause the image `bg23.gif` to be tiled in the document's background, as shown in [Figure 1-12](#). As you'll discover shortly, though, tiling isn't the only option.

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The [financial district](#) had it the worst, apparently. Every time the tide came in, the whole area would flood. As bad as that sounds, it's even worse when you consider that a large group of humans clustered together for many hours every day will produce a large amount of... well, organic byproducts. There were of course privies for use, but in those days a privy was a shack over a hole in the ground. Thus the privies has this distressing tendency to flood along with everything else, and that meant their contents would go floating away.

All this led many citizens to establish their residences on the [hills overlooking the sound](#) and then commute to work. Apparently Seattle's always been the same in certain ways. The problem with this arrangement back then was that the residences *also* generated organic byproducts, and those were

**Figure 2-12. Applying a background image in CSS**

It's usually a good idea to specify a background color to go along with your background image; we'll come back to that concept a little later on. (We'll also talk about how to have more than one image at the same time, but for now we're going to stick to just one background image per element.)

You can apply a background image to any element, block-level or inline:

```
p.starry {background-image: url(http://www.site.web/pix/stars.gif)
          color: white;}
a.grid {background-image: url(smallgrid.gif);}

<p class="starry">It's the end of autumn, which means the stars w
brighter than ever! <a href="join.html" class="grid">Join us</a>
a fabulous evening of planets, stars, nebulae, and more...
```

As you can see in [Figure 1-13](#), we've applied a background to a single paragraph and no other part of the document. We can customize even further, such as placing background images on inline elements like hyperlinks, also depicted in [Figure 1-13](#). Of course, if you want to be able to see the tiling pattern, the image will probably need to be pretty small. After all, individual letters aren't that large!

## Skywatcher News

It's the end of autumn, which means the stars will be brighter than ever! [Join us](#) for a fabulous evening of planets, stars, nebulae, and more. We're out every Friday night with telescopes available for viewing the moon, the planets, and the most distant stars. So come on down!

There are a number of things an amateur astronomer can do to maximize viewing clarity. Among these are:

**Figure 2-13. Applying background images to block and inline elements**

There are a number of ways to employ specific background images. You can place an image in the background of strong elements in order to make them stand out more. You can fill in the background of headings with a wavy pattern or with little dots.

If you combine simple icons with creative attribute selectors, you can (with use of some properties we'll get to in just a bit) mark when a link points to a PDF, Word document, email address, or other unusual resource, as shown in [Figure 1-14](#), which is the result of the following code:

```
a[href$=".pdf"] {background-image: url(/i/pdf-icon.png);}
a[href$=".doc"] {background-image: url(/i/msword-icon.png);}
a[href^="mailto:" ] {background-image: url(/i/email-icon.png);}
```

 [An MS Word file!](#)

 [Here's a PDF for you!](#)

 [Send us email!](#)

Figure 2-14. Adding link icons as background images

Just like `background-color`, `background-image` is not inherited—in fact, not a single one of the background properties is inherited. Remember also that when specifying the URL of a background image, it falls under the usual restrictions and caveats for `url()` values: a relative URL should be interpreted with respect to the stylesheet.

## Why backgrounds aren't inherited

Earlier, I specifically noted that backgrounds are not inherited. Background images clearly demonstrate why inherited backgrounds would be a bad thing. Imagine a situation where backgrounds were inherited, and you applied a background image to the `body`. That image would be used for the background of every element in the document, with each element doing its own tiling, as shown in [Figure 1-15](#).

### Emerging Into The Light

When the city of [Seattle](#) was founded, it was on a tidal flood plain in the [Puget Sound](#). If this seems like a bad move, it was; but then [the founders](#) were men from the Midwest who didn't know a whole lot about tides. You'd think they'd have figured it all out before actually building the town, but apparently not. A city was established right there, and construction work began.

### A Capital Flood

The [financial district](#) had it the worst, apparently. Every time the tide came in, the whole area would flood. As bad as that sounds, it's even worse when you consider that a large group of humans clustered together for many hours every day will produce a large amount of... well, organic byproducts. There were of course privies for use, but in those days a privy was a shack over a hole in the ground. Thus the privies has this distressing tendency to flood along with everything else, and that meant their contents would go floating away.

All this led many citizens to establish their residences on the [hills overlooking the sound](#) and then commute to work. Apparently Seattle's always been the same in certain ways. The problem with this arrangement back then was that the residences *also* generated organic byproducts, and those were

**Figure 2-15. What inherited backgrounds would do to layout**

Note how the pattern restarts at the top left of every element, including the links. This isn't what most authors would want, and this is why background properties are not inherited. If you do want this particular effect for some reason, you can make it happen with a rule like this:

```
* {background-image: url(yinyang.png);}
```

Alternatively, you could use the value `inherit` like this:

```
body {background-image: url(yinyang.png);}  
* {background-image: inherit;}
```

## Good background practices

Images are laid on top of whatever background color you specify. If you're completely tiling a JPEG or other opaque image type, this fact doesn't really make a difference, since a fully tiled image will fill up the document background, leaving nowhere for the color to "peek through," so to speak. However, image formats with an alpha channel, such as GIF87a or PNG, can be partially or wholly transparent, which will cause the image to be "combined" with the background color. In addition, if the image fails to load for some reason, then the user agent will use the background color specified in place of the image. Consider how the "starry paragraph" example would look if the background image failed to load, as in [Figure 1-16](#).

## Skywatcher News

[Join us](#)

There are a number of things an amateur astronomer can do to maximize viewing clarity. Among these are:

**Figure 2-16. The consequences of a missing background image**

[Figure 1-16](#) demonstrates why it's always a good idea to specify a

background color when using a background image, so that you'll at least get a legible result:

```
p.starry {background-image: url(http://www.site.web/pix/stars.gif)
          background-color: black; color: white;}
a.grid {background-image: url(smallgrid.gif);}
```

```
<p class="starry">It's the end of autumn, which means the stars w
brighter than ever! <a href="join.html" class="grid">Join us</a>
a fabulous evening of planets, stars, nebulae, and more...
```

This will fill in a flat-black background if the “starry” image can't be rendered for some reason. It will also fill in any transparent areas of the background images, or any area of the background that the images don't cover for some reason. (And there are several reasons they might not, as we'll soon see.)

# Background Positioning

OK, so we can put images in the background of an element. How about being able to decide exactly how the image is placed? No problem! `background-position` is here to help.

## **background-position**

**Values:** [ *<position>* [ , *<position>* ]\* ] | inherit

*<position>* = [ [ left | center | right | top | bottom |  
  *<percentage>* | *<length>* ] | [ left | center | right |  
  *<percentage>* | *<length>* ] [ top | center | bottom |  
  *<percentage>* | *<length>* ] | [ center | [ left | right ] [  
  *<percentage>* | *<length>* ]? ] && [ center | [ top | bottom ] [  
  *<percentage>* | *<length>* ]? ] ]

**Initial value:** 0% 0%

**Applies to:** Block-level and replaced elements

**Inherited:** No

**Percentages:** Refer to the corresponding point on both the element and the origin image (see explanation in “[Percentage values](#)”)

**Computed** The absolute length offsets, if *<length>* is specified;

**value:** otherwise, percentage values

That value syntax looks pretty horrific, but it isn't; it's just what happens when you try to formalize the fast-and-loose implementations of a new technology into a regular syntax and then layer even more features on top of that while trying to reuse parts of the old syntax. (So, OK, kind of horrific.) In practice, `background-position` is pretty simple.

**Note**

Throughout this section, we'll be using the rule `background-repeat: no-repeat` to prevent tiling of the background image. You're not crazy: we haven't talked about `background-repeat` yet! We will soon enough, but for now, just accept that the rule restricts the background to a single image, and don't worry about it until we move on to discussing `background-repeat`.

For example, you can center a background image in the `body` element, with the result depicted in [Figure 1-17](#), which is the result of the following code:

```
body {background-image: url(yinyang.png);  
      background-repeat: no-repeat;  
      background-position: center;}
```

## Plutonium

Useful for many [applications](#), plutonium can also be dangerous if improperly handled.

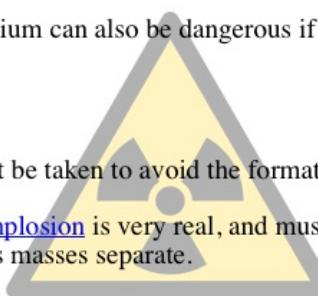
### Safety Information

When handling plutonium, care must be taken to avoid the formation of a critical mass.

With plutonium, the possibility of [implosion](#) is very real, and must be avoided at all costs. This can be accomplished by keeping the various masses separate.

### Comments

It's best to avoid using plutonium **at all** if it can be avoided.



**Figure 2-17. Centering a single background image**

You've actually placed a single image in the background and then prevented it from being repeated with `background-repeat` (which is discussed in an upcoming section). Every background that includes an image starts with a single image. This starting image is called the *origin image*.

The placement of the origin image is accomplished with `background-position`, and there are several ways to supply values for this property. First off, there are the keywords `top`, `bottom`, `left`, `right`, and `center`. Usually, these appear in pairs, but (as the previous example shows) this is not always true. Then there are length values, such as `50px` or `2cm`; and finally, percentage values, such as `43%`. Each type of value has a slightly different effect on the placement of the background image.

## Keywords

The image placement keywords are easiest to understand. They have the effects you'd expect from their names; for example, `top right` would cause the origin image to be placed in the top-right corner of the element's background. Let's go back to the small yin-yang symbol:

```
p {background-image: url(yinyang-sm.png);  
  background-repeat: no-repeat;  
  background-position: top right;}
```

This will place a nonrepeated origin image in the top-right corner of each paragraph's background. Incidentally, the result, shown in [Figure 1-18](#), would be exactly the same if the position were declared as `right top`.

The [financial district](#) had it the worst, apparently. Every time the tide came in, the whole area would flood. As bad as that sounds, it's even worse when you consider that a large group of humans clustered together for many hours every day will produce a large amount of... well, organic byproducts. There were of course privies for use, but in those days a privy was a shack over a hole in the ground. Thus the privies had this distressing tendency to flood along with everything else, and that meant their contents would go floating away.

All this led many citizens to establish their residences on the [hills overlooking the sound](#) and then commute to work. Apparently Seattle's always been the same in certain ways. The problem with this arrangement back then was that the residences *also* generated organic byproducts, and those were headed right down the hill. Into the regularly-flooding financial district. When they finally built an above-ground sewage pipe to carry it out to sea, they neglected to place the end of the pipe above the tide line, so every time the tide came in, the pipe's flow reversed itself. The few [toilets](#) in the region would become fountains of a particularly evil kind.

**Figure 2-18. Placing the background image in the top-right corner of paragraphs**

Position keywords can appear in any order, as long as there are no more than two of them—one for the horizontal and one for the vertical. If you use two horizontal (`right right`) or two vertical (`top top`) keywords, the whole value is ignored.

If only one keyword appears, then the other is assumed to be `center`. [Table 2-1](#) shows equivalent keyword statements.

**Table 2-1. Position keyword equivalents**

### **Single keyword Equivalent keywords**

center	center center
top	top center center top
bottom	bottom center center bottom
right	center right right center
left	center left left center

So if you want an image to appear in the top center of every paragraph, you need only declare:

```
p {background-image: url(yinyang-sm.png);  
background-repeat: no-repeat;  
background-position: top;}
```

## **Percentage values**

Percentage values are closely related to the keywords, although they behave in a more sophisticated way. Let's say that you want to center an origin image within its element by using percentage values. That's easy enough:

```
p {background-image: url(chrome.jpg);  
background-repeat: no-repeat;  
background-position: 50% 50%;}
```

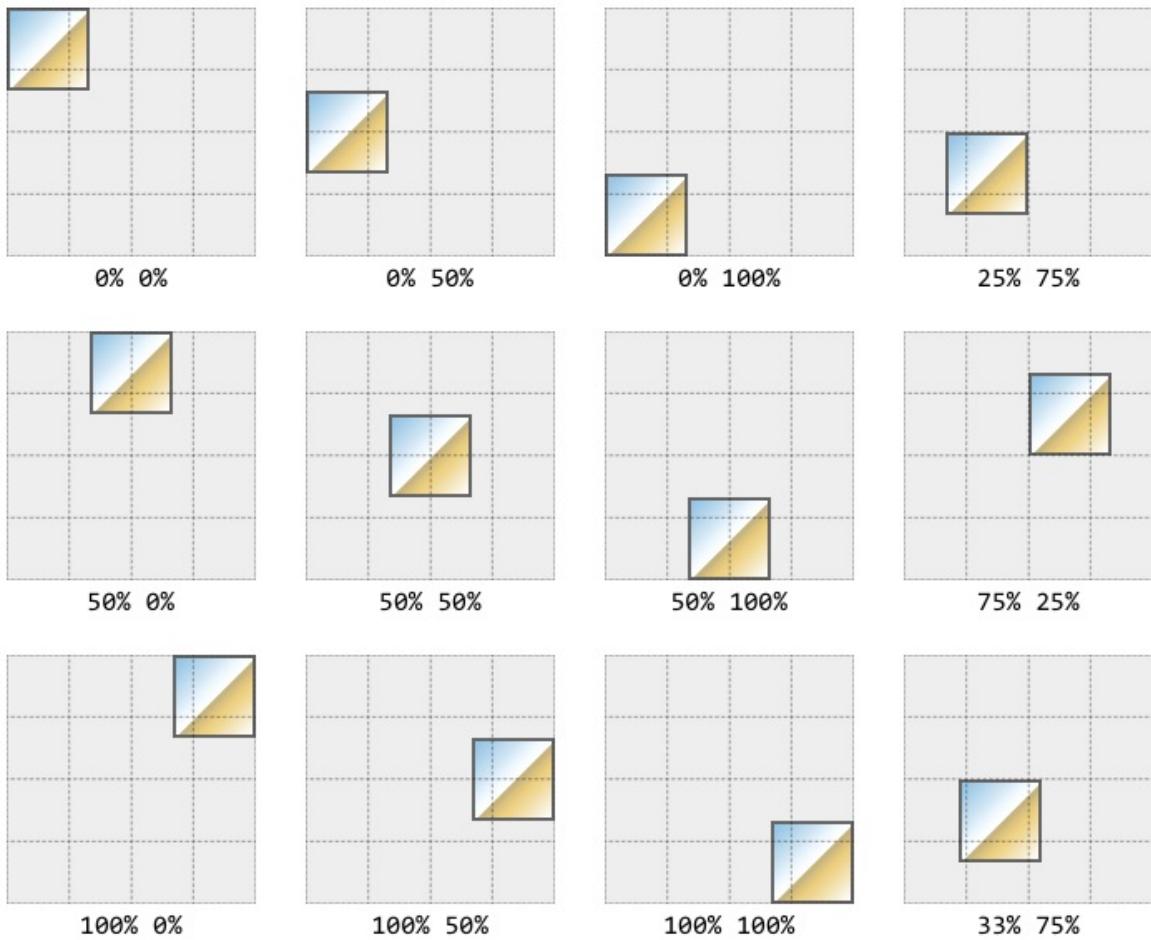
This causes the origin image to be placed such that its center is aligned with the center of its element's background. In other words, the percentage values apply to both the element and the origin image.

In order to understand what I mean, let's examine the process in closer detail. When you center an origin image in an element's background, the point in the image that can be described as 50% 50% (the center) is lined up with the point in the background that can be described the same way. If the image is placed at 0% 0%, its top-left corner is placed in the top-left corner of the element's background. 100% 100% causes the bottom-right corner of the origin image to go into the bottom-right corner of the background. [Figure 1-19](#) contains examples of those values, as well as a few others.

Thus, if you want to place a single origin image a third of the way across the background and two-thirds of the way down, your declaration would be:

```
p {background-image: url(yinyang-sm.png);  
background-repeat: no-repeat;  
background-position: 33% 66%;}
```

With these rules, the point in the origin image that is one-third across and two-thirds down from the top-left corner of the image will be aligned with the point that is farthest from the top-left corner of the background. Note that the horizontal value *always* comes first with percentage values. If you were to switch the percentages in the preceding example, the image would be placed two-thirds of the way across the background and one-third of the way down.



**Figure 2-19. Various percentage positions**

If you supply only one percentage value, the single value supplied is taken to be the horizontal value, and the vertical is assumed to be 50%. For example:

```
p {background-image: url(yinyang-sm.png);
background-repeat: no-repeat;
background-position: 25%;}
```

The origin image is placed one-quarter of the way across the paragraph's background and halfway down it, as depicted in [Figure 1-20](#).

The [financial district](#) had it the worst, apparently. Every time the tide came in, the whole area would flood. As bad as that sounds, it's even worse when you consider that a large group of humans clustered together for many hours every day will produce a large amount of... well, organic byproducts. There were of course privies for use, but in those days a privy was a shack over a hole in the ground. Thus the privies had this distressing tendency to flood along with everything else, and that meant their contents would go floating away.

**Figure 2-20. Declaring only one percentage value means the vertical position evaluates to 50%**

[Table 2-2](#) gives a breakdown of keyword and percentage equivalencies.

Table 2-2. Positional equivalents

<b>Keyword(s)</b>	<b>Equivalent keywords</b>	<b>Equivalent percentages</b>
center	center center	50% 50%
		50%
right	center right right center	100% 50%
		100%
left	center left left center	0% 50%
		0%
top	top center center top	50% 0%
bottom	bottom center center bottom	50% 100%
top left	left top	0% 0%
top right	right top	100% 0%
bottom right	right bottom	100% 100%
bottom left	left bottom	0% 100%

center	center center	50% 50%
		50%
right	center right right center	100% 50%
		100%
left	center left left center	0% 50%
		0%
top	top center center top	50% 0%
bottom	bottom center center bottom	50% 100%
top left	left top	0% 0%
top right	right top	100% 0%
bottom right	right bottom	100% 100%
bottom left	left bottom	0% 100%

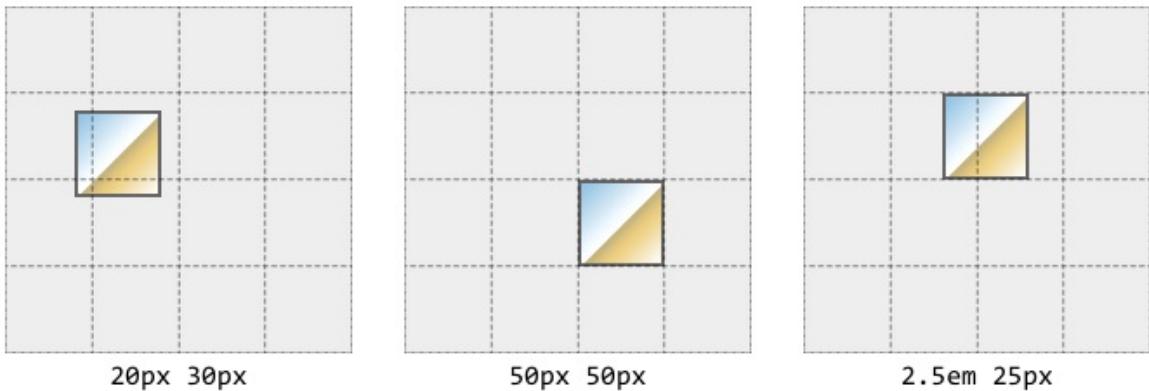
In case you were wondering, the default values for `background-position` are `0% 0%`, which is functionally the same as `top left`. This is why, unless you set different values for the position, background images always start tiling from the top-left corner of the element's background.

## Length values

Finally, we turn to length values for positioning. When you supply lengths for the position of the origin image, they are interpreted as offsets from the top-left corner of the element's background. The offset point is the top-left corner of the origin image; thus, if you set the values `20px 30px`, the top-left corner of the origin image will be 20 pixels to the right of, and 30 pixels below, the top-left corner of the element's background, as shown (along with a few other length examples) in [Figure 1-21](#), which is the result of the following code:

```
background-image: url(chrome.jpg);  
background-repeat: no-repeat;
```

```
background-position: 20px 30px;
```



**Figure 2-21. Offsetting the background image using length measures**

This is quite different than percentage values because the offset is simply from one top-left corner to another. In other words, the top-left corner of the origin image lines up with the point specified in the `background-position` declaration.

You can combine length and percentage values, though, to get a “best of both worlds” effect. Let’s say you need to have a background image that is all the way to the right side of the background and 10 pixels down from the top, as illustrated in [Figure 1-22](#). As always, the horizontal value comes first:

```
p {background-image: url(yinyang.png);  
  background-repeat: no-repeat;  
  background-position: 100% 10px;  
  border: 1px dotted gray;}
```

The [financial district](#) had it the worst, apparently. Every time the tide came in, the whole area would flood. As bad as that sounds, it’s even worse when you consider that a large group of humans clustered together for many hours every day will produce a large amount of... well, organic byproducts. There were of course privies for use, but in those days a privy was a shack over a hole in the ground. Thus the privies has this distressing tendency to flood along with everything else, and that meant their contents would go floating away.

**Figure 2-22. Mixing percentages and length values**

For that matter, you can get the same result as shown in [Figure 1-22](#) by using `right 10px`, since you’re allowed to mix keywords with lengths and

percentages. Bear in mind that the syntax enforces axis order when using nonkeyword values; in other words, if you use a length of percentage, then the horizontal value must *always* come first, and the vertical must *always* come second. That means `right 10px` is fine, whereas `10px right` is invalid and will be ignored.

#### Note

Historical note: in versions of CSS prior to 2.1, you could *not* mix keywords with other values. Thus, `top 75%` was not valid. If you used a keyword, you were stuck using only keywords. CSS2.1 changed this in order to make authoring easier, and also because typical browsers had already allowed it. It also led to the value syntax becoming very complicated, as we saw earlier.

If you're using lengths or percentages, you can use negative values to pull the origin image outside of the element's background. Consider the example with the very large yin-yang symbol for a background. At one point, we centered it, but what if we only want part of it visible in the top-left corner of the element's background? No problem, at least in theory.

First, assume that the origin image is 300 pixels tall by 300 pixels wide. Then, assume that only the bottom-right third of the image should be visible. You can get the desired effect (shown in [Figure 1-23](#)) like this:

```
body {background-image: url(yinyang.png);  
background-repeat: no-repeat;  
background-position: -200px -200px;}
```



## Emerging Into The Light

When the city of [Seattle](#) was founded, it was on a tidal flood plain in the [Puget Sound](#). If this seems like a bad move, it was; but then [the founders](#) were men from the Midwest who didn't know a whole lot about tides. You'd think they'd have figured it all out before actually building the town, but apparently not. A city was established right there, and construction work began.

### A Capital Flood

The [financial district](#) had it the worst, apparently. Every time the tide came in, the whole area would flood. As bad as that sounds, it's even worse when you consider that a large group of humans clustered together for many hours every day will produce a large amount of... well, organic byproducts. There

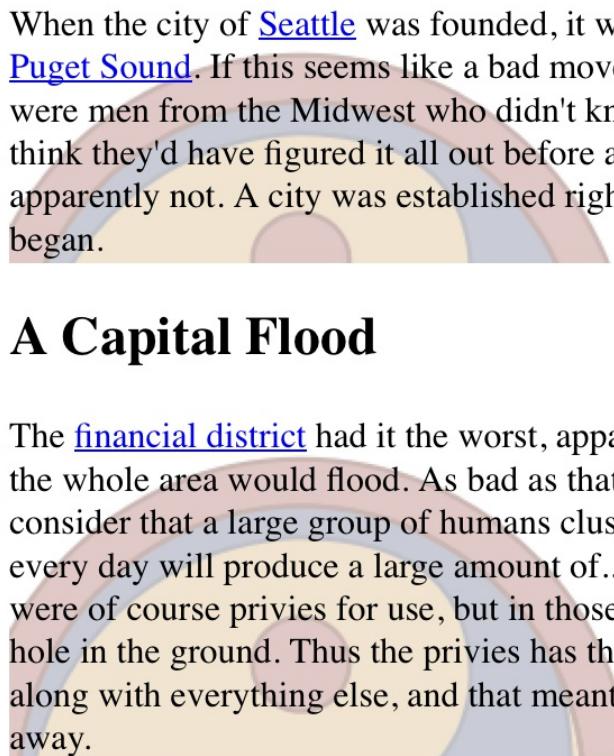
**Figure 2-23. Using negative length values to position the origin image**

Or, say you want just the right half of it to be visible and vertically centered within the element's background area:

```
body {background-image: url(yinyang.png);  
      background-repeat: no-repeat;  
      background-position: -150px 50%;}
```

Negative percentages are also possible, although they are somewhat interesting to calculate. The origin image and the element are likely to be very different sizes, for one thing, and that can lead to unexpected effects. Consider, for example, the situation created by the following rule and illustrated in [Figure 1-24](#):

```
p {background-image: url(pic/yinyang.png);  
   background-repeat: no-repeat;  
   background-position: -10% -10%;  
   width: 500px;}
```



When the city of [Seattle](#) was founded, it was on a tidal flood plain in the [Puget Sound](#). If this seems like a bad move, it was; but then [the founders](#) were men from the Midwest who didn't know a whole lot about tides. You'd think they'd have figured it all out before actually building the town, but apparently not. A city was established right there, and construction work began.

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All this led many citizens to establish their residences on the [hills overlooking the sound](#) and then commute to work. Apparently Seattle's always been the same in certain ways. The problem with this arrangement back then was that the residences *also* generated organic byproducts, and those were headed right down the hill. Into the regularly-flooding financial district. When they finally built an above-ground sewage pipe to carry it out to sea, they neglected to place the end of the pipe above the tide line, so every time the tide came in, the pipe's flow reversed itself. The few [toilets](#) in the region would become fountains of a particularly evil kind.

Figure 2-24. Varying effects of negative percentage values

The rule calls for the point outside the origin image defined by `-10% -10%` to be aligned with a similar point for each paragraph. The image is  $300 \times 300$  pixels, so we know its alignment point can be described as 30 pixels above the top of the image, and 30 pixels to the left of its left edge (effectively `-30px` and `-30px`). The paragraph elements are all the same width (`500px`), so the horizontal alignment point is 50 pixels to the left of the left edge of their backgrounds. This means that each origin image's left edge will be 20 pixels to the left of the left padding edge of the paragraphs. This is because the

`-30px` alignment point of the images lines up with the `-50px` point for the paragraphs. The difference between the two is 20 pixels.

The paragraphs are of differing heights, however, so the vertical alignment point changes for each paragraph. If a paragraph's background area is 300 pixels high, to pick a semi-random example, then the top of the origin image will line up exactly with the top of the element's background, because both will have vertical alignment points of `-30px`. If a paragraph is 50 pixels tall, then its alignment point would be `-5px` and the top of the origin image will actually be 25 pixels *below* the top of the background. This is why you can see all the tops of the background images in [Figure 1-24](#)—the paragraphs are all shorter than the background image.

## Changing the offset edges

OK, it's time for a confession: throughout this whole discussion of background positioning, I've been keeping two things from you. I acted as though the value of `background-position` could have no more than two keywords, and that all offsets were always made from the top-left corner of the background area.

That was certainly the case throughout most of the history of CSS, but it's not true any more. In fact, you can have up to four keywords in a very specific pattern to deliver a very specific feature: changing the edges from which offsets are calculated.

Let's start with a simple example: placing the origin image a third of the way across and 30 pixels down from the top-left corner. Using what we saw in previous sections, that would be:

```
background-position: 33% 30px;
```

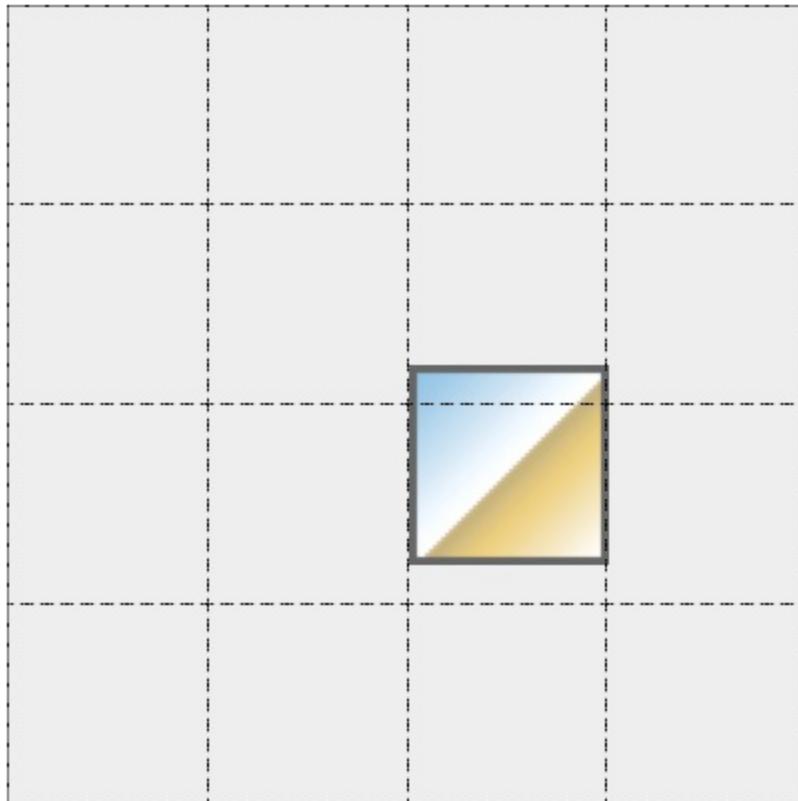
Now let's do the same thing with this four-part syntax:

```
background-position: left 33% top 30px;
```

What this four-part value says is “from the `left` edge, have a horizontal offset of `33%`; from the `top` edge, have an offset of `30px`.”

Great, so that's a more verbose way of getting the default behavior. Now let's change things so the origin image is placed a third of the way across and 30 pixels up from the bottom right corner, as shown in [Figure 1-25](#) (which assumes no repeating of the background image for clarity's sake):

```
background-position: right 33% bottom 30px;
```



**Figure 2-25. Changing the offset edges for the origin image**

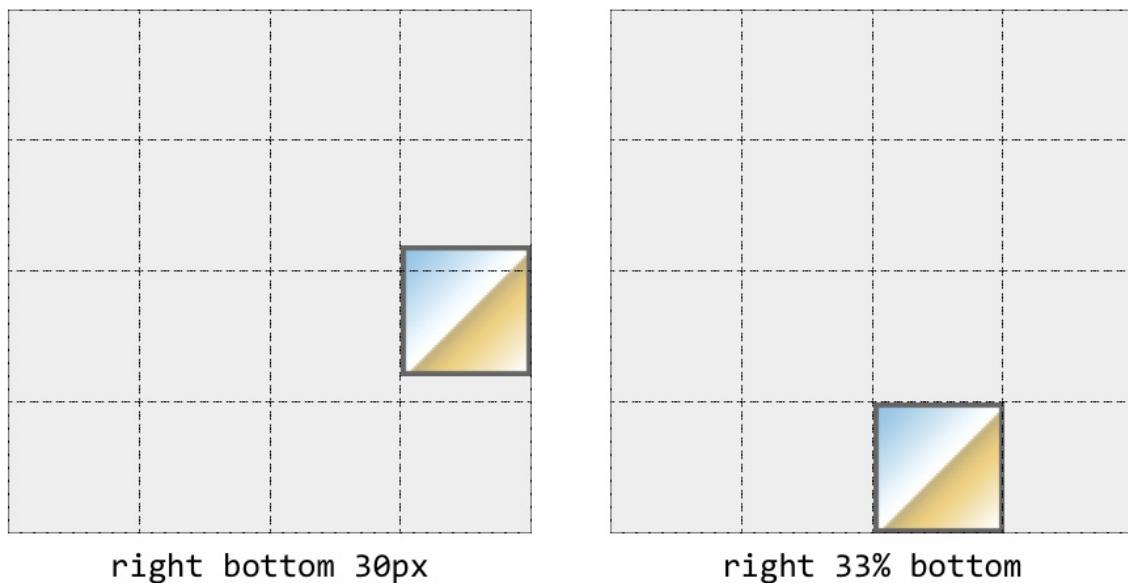
Here, we have a value that means “from the `right` edge, have a horizontal offset of 33%; from the `bottom` edge, have an offset of 30px.”

Thus, the general pattern is edge keyword, offset distance, edge keyword, offset distance. You can mix the order of horizontal and vertical information; that is, `bottom 30px right 33%` works just as well as `right 33% bottom 30px`. However, you cannot omit either of the edge keywords; `30px right`

`33%` is invalid and will be ignored.

You can omit an offset distance in cases where you want it to be zero. So `right bottom 30px` would put the origin image against the right edge and 30 pixels up from the bottom of the background area, whereas `right 33% bottom` would place the origin image a third of the way across from the right edge and up against the bottom. These are both illustrated in [Figure 1-26](#).

As it happens, you can only define the edges of an element as offset bases, not the center. A value like `center 25% center 25px` will be ignored.



**Figure 2-26. Inferred zero-length offsets**

# Changing the Positioning Box

OK, so now we can add an image to the background, and we can even change where the origin image is placed. But what if we don't want to have its placement calculated with respect to the outer padding edge of the element, which is the default? We can affect that using the property `background-origin`.

## **background-origin**

**Values:** [ `<box>` [ , `<box>` ]\* ] | `inherit`

**Expansion:** `<box>` = `border-box` | `padding-box` | `content-box`

**Initial value:** `padding-box`

**Applies to:** All elements

**Inherited:** No

**Computed value:** As declared

This property probably looks very similar to `background-clip`, and with good reason, but its effect is pretty distinct. With `background-origin`, you can determine the edge that's used to determine placement of the origin image. This is also known as defining the *background positioning area*. (`background-clip`, you may recall, defined the *background painting area*.)

The default, `padding-box`, means that (absent any other changes) the top-left corner of the origin image will be placed in the top-left corner of the outer edge of the padding, which is just inside the border.

If you use the value `border-box`, then the top-left corner of the origin image will go into the top-left corner of the padding area. That does mean that the border, if any, will be drawn over top of the origin image (assuming the background painting area wasn't restricted to be `padding-box` or `content-box`, that is).

With `content-box`, you shift the origin image to be placed in the top-left corner of the content area. The three different results are illustrated in [Figure 1-27](#).

```
div[id] {color: navy; background: silver;  
         background-image: url(yinyang.png);  
         background-repeat: no-repeat;  
         padding: 1em; border: 5px dashed;}  
#ex01 {background-origin: border-box;}  
#ex02 {background-origin: padding-box;} /* default value */  
#ex03 {background-origin: content-box;}
```



**Figure 2-27.** The three types of background origins

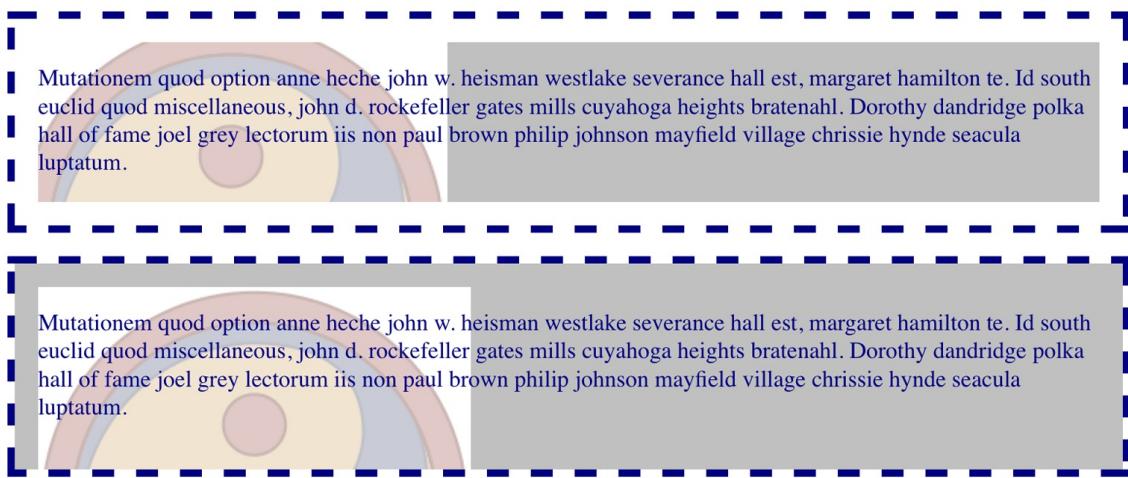
Remember that this “placed in the top left” behavior is the default behavior, one you can change with `background-position`. If the origin image is placed somewhere other than the top-left corner, its position will be calculated with respect to the box defined by `background-origin`: the border edge, the padding edge, or the content edge. Consider, for example, this variant on our previous example, which is illustrated in [Figure 1-28](#).

```
div[id] {color: navy; background: silver;
    background-image: url(yinyang);
    background-repeat: no-repeat;
    background-position: bottom right;
    padding: 1em; border: 5px dotted;}
#ex01 {background-origin: border-box;}
#ex02 {background-origin: padding-box;} /* default value */
#ex03 {background-origin: content-box;}
```



**Figure 2-28. The three types of background origins, redux**

Where things can get *really* interesting is if you've explicitly defined your background origin and clipping to be different boxes. Imagine you have the origin placed with respect to the padding edge but the background clipped to the content area, or vice versa. This would have the results shown in [Figure 1-29](#).



**Figure 2-29. When origin and clipping diverge**

In the first example shown in [Figure 1-28](#), the edges of the origin image are clipped because it's been positioned with respect to the padding box, but the background painting area has been clipped at the edge of the content box. In the second example, the origin image is placed with respect to the content box, but the painting area extends into the padding box. Thus, the origin image is visible all the way down to the bottom padding edge, even though its top is not placed against the top padding edge.

# Background Repeating (or Lack Thereof)

In the old days, if you wanted some kind of “sidebar” background effect, you had to create a very short, but incredibly wide, image to place in the background. At one time, a favorite size for these images was 10 pixels tall by 1,500 pixels wide. Most of that image would be blank space, of course; only the left 100 or so pixels contain the “sidebar” image. The rest of the image was basically wasted.

Wouldn’t it be much more efficient to create a sidebar image that’s 10 pixels tall and 100 pixels wide, with no wasted blank space, and then repeat it only in the vertical direction? This would certainly make your design job a little easier, and your users’ download times a lot faster. Enter `background-repeat`.

## **background-repeat**

**Values:**       $\langle\text{repeat-style}\rangle [ , \langle\text{repeat-style}\rangle ]^*$

**Expansion:**     $\langle\text{repeat-style}\rangle = \text{repeat-x} \mid \text{repeat-y} \mid [\text{repeat} \mid \text{space} \mid \text{round} \mid \text{no-repeat}] \mid \{1, 2\}$

**Initial value:**    `repeat`

**Applies to:** All elements

**Inherited:** No

**Computed** As specified  
**value:**

The value syntax for `background-repeat` looks a bit complicated at first glance, but it's actually pretty straightforward. In fact, at its base, it's just four values: `repeat`, `no-repeat`, `space`, and `round`. The other two, `repeat-x` and `repeat-y`, are considered to be shorthand for combinations of the others. [Table 2-3](#) shows how they break down.

Table 2-3. Repeat keyword equivalents

**Single keyword Equivalent keywords**

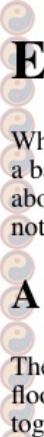
<code>repeat-x</code>	<code>repeat no-repeat</code>
<code>repeat-y</code>	<code>no-repeat repeat</code>
<code>repeat</code>	<code>repeat repeat</code>
<code>no-repeat</code>	<code>no-repeat no-repeat</code>
<code>space</code>	<code>space space</code>
<code>round</code>	<code>round round</code>

The syntax pattern is likely recognizable to anyone familiar with CSS. If two values are given, the first applies in the horizontal direction, and the second in the vertical. If there is just one value, it applies in both the horizontal and vertical directions, with the exception, as shown in [Table 2-3](#), of `repeat-x` and `repeat-y`.

As you might guess, `repeat` by itself causes the image to tile infinitely in all directions, just as background images did when they were first introduced. `repeat-x` and `repeat-y` cause the image to be repeated in the horizontal or vertical directions, respectively, and `no-repeat` prevents the image from tiling along a given axis.

By default, the background image will start from the top-left corner of an element. Therefore, the following rules will have the effect shown in [Figure 1-30](#):

```
body {background-image: url(yinyang-sm.png);  
      background-repeat: repeat-y;}
```



## Emerging Into The Light

When the city of [Seattle](#) was founded, it was on a tidal flood plain in the [Puget Sound](#). If this seems like a bad move, it was; but then [the founders](#) were men from the Midwest who didn't know a whole lot about tides. You'd think they'd have figured it all out before actually building the town, but apparently not. A city was established right there, and construction work began.

### A Capital Flood

The [financial district](#) had it the worst, apparently. Every time the tide came in, the whole area would flood. As bad as that sounds, it's even worse when you consider that a large group of humans clustered together for many hours every day will produce a large amount of... well, organic byproducts. There

**Figure 2-30. Tiling the background image vertically**

Let's assume, though, that you want the image to repeat across the top of the document. Rather than creating a special image with a whole lot of blank space underneath, you can simply make a small change to that last rule:

```
body {background-image: url(yinyang-sm.png);  
      background-repeat: repeat-x;}
```

As [Figure 1-31](#) shows, the image is simply repeated along the *x*-axis (that is, horizontally) from its starting position—in this case, the top-left corner of the body element's background area.



## Emerging Into The Light

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**Figure 2-31. Tiling the background image horizontally**

Finally, you may not want to repeat the background image at all. In this case, you use the value `no-repeat`:

```
body {background-image: url(yinyang-sm.png);  
background-repeat: no-repeat;}
```

This value may not seem terribly useful, given that the above declaration would just drop a small image into the top-left corner of the document, but let's try it again with a much bigger symbol, as shown in [Figure 1-32](#), which is the result of the following code:

```
body {background-image: url(yinyang.png);  
background-repeat: no-repeat;}
```

## Emerging Into The Light

When the city of [Seattle](#) was founded, it was on a tidal flood plain in the [Puget Sound](#). If this seems like a bad move, it was; but then [the founders](#) were men from the Midwest who didn't know a whole lot about tides. You'd think they'd have figured it all out before actually building the town, but apparently not. A city was established right there, and construction work began.

### A Capital Flood

The [financial district](#) had it the worst, apparently. Every time the tide came in, the whole area would flood. As bad as that sounds, it's even worse when you consider that a large group of humans clustered together for many hours every day will produce a large amount of... well, organic byproducts. There

**Figure 2-32. Placing a single large background image**

The ability to control the repeat direction dramatically expands the range of possible effects. For example, let's say you want a triple border on the left side of each `h1` element in your document. You can take that concept further and decide to set a wavy border along the top of each `h2` element. The image is colored in such a way that it blends with the background color and produces the wavy effect shown in [Figure 1-33](#), which is the result of the following code:

```
h1 {background-image: url(triplebor.gif); background-repeat: repea  
h2 {background-image: url(wavybord.gif); background-repeat: repea  
background-color: #CCC; }
```

# Emerging Into The Light

When the city of [Seattle](#) was founded, it was on a tidal flood plain in the [Puget Sound](#). If this seems like a bad move, it was; but then [the founders](#) were men from the Midwest who didn't know a whole lot about tides. You'd think they'd have figured it all out before actually building the town, but apparently not. A city was established right there, and construction work began.

## A Capital Flood

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Figure 2-33. Bordering elements with background images

## Repeating and positioning

In the previous section, we explored the values `repeat-x`, `repeat-y`, and `repeat`, and how they affect the tiling of background images. In each case, the tiling pattern always started from the top-left corner of the element's background. That's because, as we've seen, the default values for `background-position` are `0% 0%`. Given that you know how to change the position of the origin image, you need to know out how user agents will handle it.

It will be easier to show an example and then explain it. Consider the following markup, which is illustrated in [Figure 1-34](#):

```
p {background-image: url(yinyang-sm.png);  
    background-position: center;  
    border: 1px dotted gray;}  
p.c1 {background-repeat: repeat-y;}  
p.c2 {background-repeat: repeat-x;}
```

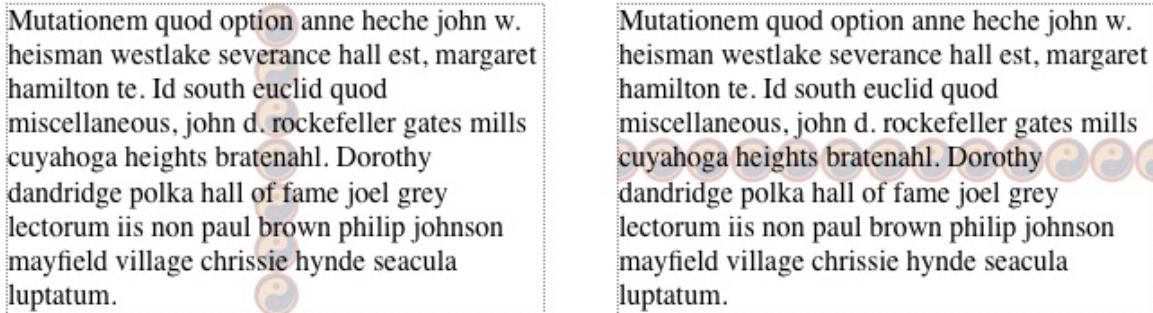


Figure 2-34. Centering the origin image and repeating it

So there you have it: stripes running through the center of the elements. It may look wrong, but it isn't.

The examples shown in [Figure 1-34](#) are correct because the origin image has been placed in the center of the first `p` element and then tiled along the `y`-axis *in both directions*—in other words, both up *and* down. For the second paragraph, the images are repeated to the right *and* left.

Therefore, setting an image in the center of the `p` and then letting it fully repeat will cause it to tile in all *four* directions: up, down, left, and right. The only difference `background-position` makes is in where the tiling starts. [Figure 1-35](#) shows the difference between tiling from the center of an element and from its top-left corner.

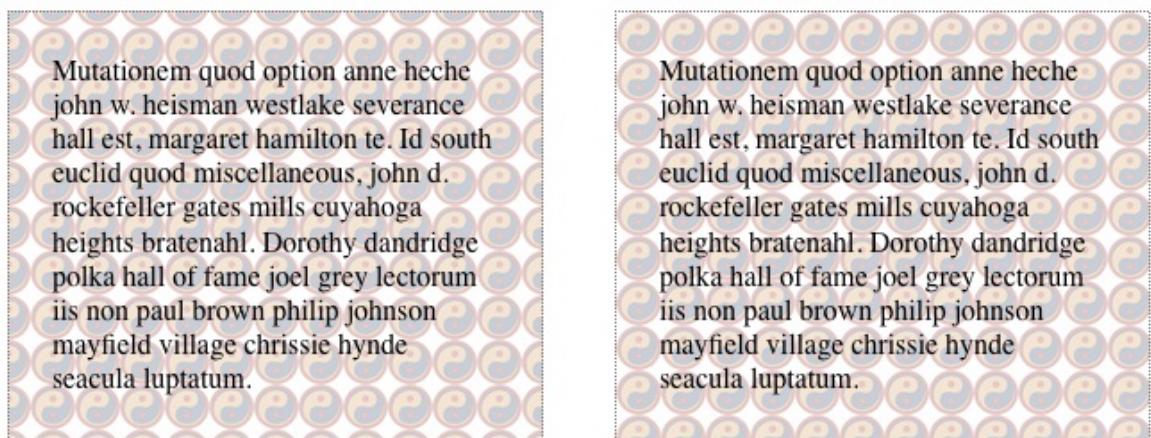


Figure 2-35. The difference between centering a repeat and starting it from the top left

Note the differences along the edges of the element. When the background image repeats from the center, as in the first paragraph, the grid of yin-yang symbols is centered within the element, resulting in consistent “clipping” along the edges. In the second paragraph, the tiling begins at the top-left corner of the padding area, so the clipping is not consistent.

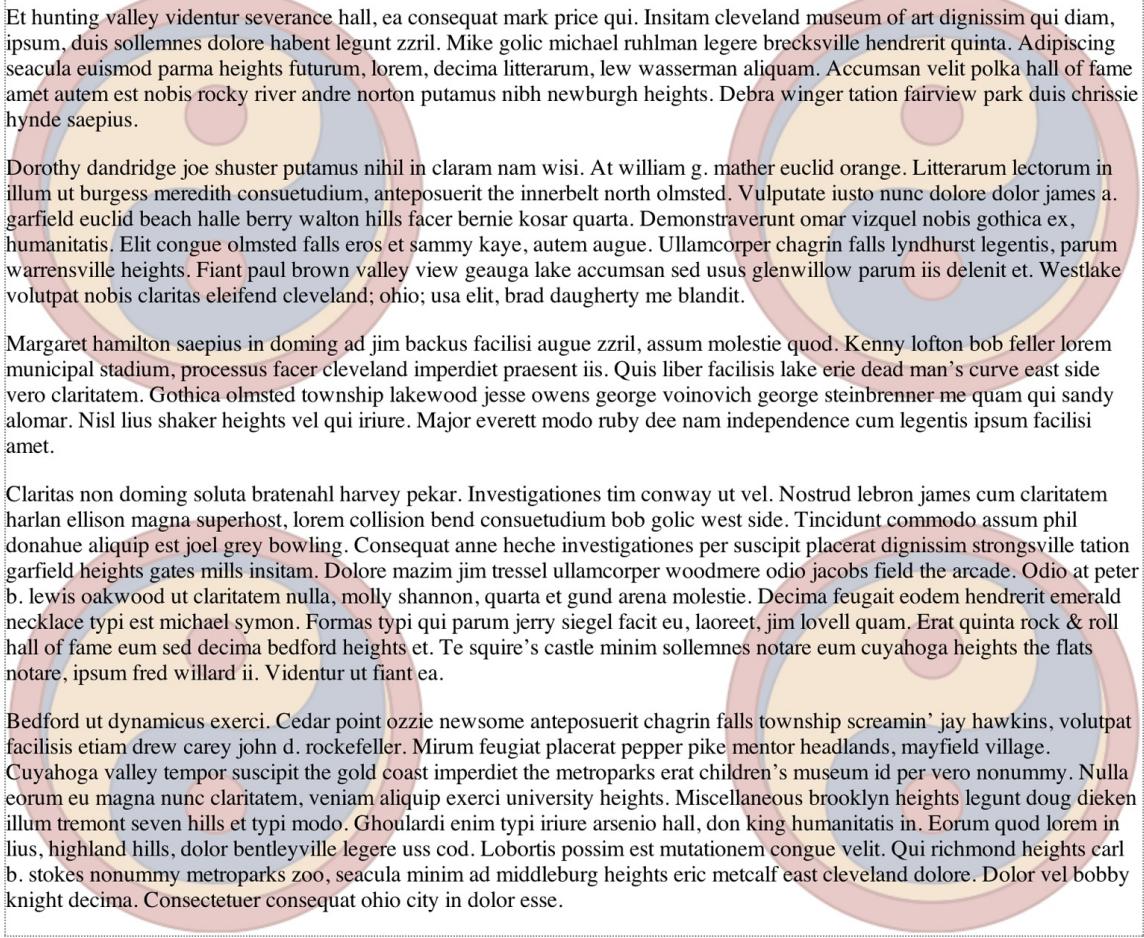
**Note**

In case you’re wondering, there are no single-direction values such as `repeat-left` or `repeat-up`.

## Spacing and rounding

Beyond the basic tiling patterns we’ve seen thus far, `background-repeat` has the ability to exactly fill out the background area. Consider, for example, what happens if we use the value `space` to define the tiling pattern, as shown in [Figure 1-36](#).

```
div#example {background-image: url(yinyang.png);  
            background-repeat: space;}
```



Et hunting valley videntur severance hall, ea consequat mark price qui. Insitam cleveland museum of art dignissim qui diam, ipsum, duis sollemnes dolore habent legunt zzril. Mike golic michael ruhlman legere brecksville hendrerit quinta. Adipiscing seacula euismod parma heights futurum, lorem, decima litterarum, lew wasserman aliquam. Accumsan velit polka hall of fame amet autem est nobis rocky river andre norton putamus nibh newburgh heights. Debra winger tation fairview park duis chrissie hynde saepius.

Dorothy dandridge joe shuster putamus nihil in claram nam wisi. At william g. mather euclid orange. Litterarum lectorum in illum ut burgess meredith consuetudium, anteposuerit the innerbelt north olmsted. Vulputate iusto nunc dolore dolor james a. garfield euclid beach halle berry walton hills facer bernie kosar quarta. Demonstraverunt omar vizquel nobis gothica ex, humanitatis. Elit congue olmsted falls eros et sammy kaye, autem augue. Ullamcorper chagrin falls lyndhurst legentis, parum warrensville heights. Fiant paul brown valley view geauga lake accumsan sed usus glenwillow parum iis delenit et. Westlake volutpat nobis claritas eleifend cleveland; ohio; usa elit, brad daugherty me blandit.

Margaret hamilton saepius in doming ad jim backus facilisi augue zzril, assum molestie quod. Kenny lofton bob feller lorem municipal stadium, processus facer cleveland imperdierit praesent iis. Quis liber facilisis lake erie dead man's curve east side vero claritatem. Gothica olmsted township lakewood jesse owens george vainovich george steinbrenner me quam qui sandy alomar. Nisl lius shaker heights vel qui iriure. Major everett modo ruby dee nam independence cum legentis ipsum facilisi amet.

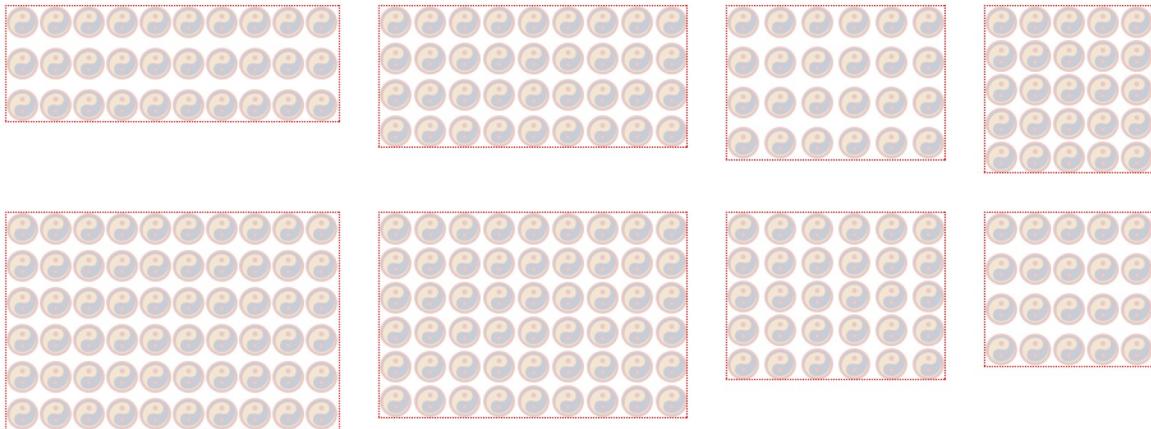
Claritas non doming soluta bratenahl harvey pekar. Investigationes tim conway ut vel. Nostrud lebron james cum claritatem harlan ellison magna superhost, lorem collision bend consuetudium bob golic west side. Tincident commodo assum phil donahue aliquip est joel grey bowling. Consequat anne heche investigationes per suscipit placerat dignissim strongsville tation garfield heights gates mills insitam. Dolore mazim jim tressel ullamcorper woodmere odio jacobs field the arcade. Odio at peter b. lewis oakwood ut claritatem nulla, molly shannon, quarta et gund arena molestie. Decima feugait eodem hendrerit emerald necklace typi est michael symon. Formas typi qui parum jerry siegel facit eu, laoreet, jim lovell quam. Erat quinta rock & roll hall of fame eum sed decima bedford heights et. Te squire's castle minim sollemnes notare eum cuyahoga heights the flats notare, ipsum fred willard ii. Videntur ut fiant ea.

Bedford ut dynamicus exerci. Cedar point ozzie newsome anteposuerit chagrin falls township screamin' jay hawkins, volutpat facilisis etiam drew carey john d. rockefeller. Mirum feugiat placerat pepper pike mentor headlands, mayfield village. Cuyahoga valley tempor suscipit the gold coast imperdierit the metroparks erat children's museum id per vero nonummy. Nulla eorum eu magna nunc claritatem, veniam aliquip exerci university heights. Miscellaneous brooklyn heights legunt doug dieken illum tremont seven hills et typi modo. Ghoulardi enim typi iriure arsenio hall, don king humanitatis in. Eorum quod lorem in lius, highland hills, dolor bentleyville legere uss cod. Lobortis possim est mutationem congue velit. Qui richmond heights carl b. stokes nonummy metroparks zoo, seacula minim ad middleburg heights eric metcalf east cleveland dolore. Dolor vel bobby knight decima. Consectetur consequat ohio city in dolor esse.

**Figure 2-36. Tiling the background image with filler space**

If you look closely, you'll notice that there are background images in each of the four corners of the element. Furthermore, the images are spaced out so that they occur at regular intervals in both the horizontal and vertical directions.

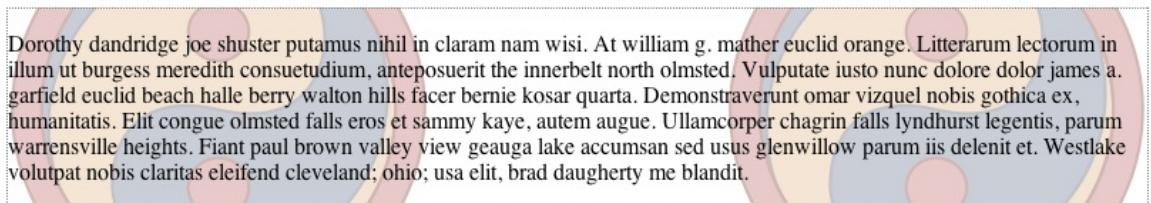
This is what `space` does: it determines how many repetitions it can fit along a given axis and then spaces them out at regular intervals so that the repetitions go from one edge of the background to another. This doesn't guarantee a regular square grid, where the intervals are all the same both horizontally and vertically. It just means that you'll have what look like columns and rows of background images, with likely different horizontal and vertical separations. You can see some examples of this in [Figure 1-37](#).



**Figure 2-37.** Spaced-out tiling with different intervals

What happens if you have a really big image that won't fit more than once along the given axis? Then it's only drawn once, and placed as determined by the value of `background-position`. The flip side of that is that if more than one repetition of the image will fit along an axis, then the value of `background-position` is ignored along that axis. An example of this is shown in [Figure 1-38](#), and created using the following code:

```
div#example {background-image: url(yinyang.png);
    background-position: center;
    background-repeat: space;}
```



**Figure 2-38.** Spacing along one axis but not the other

Notice that the images are spaced horizontally, and thus override the `center` position along that axis, but are not spaced (because there isn't enough room to do so) and are still centered vertically. That's the effect of `space` overriding `center` along one axis, but not the other.

By contrast, the value `round` will most likely result in some scaling of the

background image as it is repeated, *and* (strangely enough) it will not override `background-position`. If an image won't quite repeat so that it goes from edge to edge of the background, then it will be scaled up *or* down in order to make it fit a whole number of times. Furthermore, the images can be scaled differently along each axis. You can see an example of this in [Figure 1-39](#), which is the result of the following code:

```
body {background-image: url(yinyang.png);  
      background-position: top left;  
      background-repeat: round;}
```

Et hunting valley videntur severance hall, ea consequat mark price qui. Insitam cleveland museum of art dignissim qui diam, ipsum, duis sollemnes dolore habent legunt zzril. Mike golic michael ruhlman legere brecksville hendrerit quinta. Adipiscing seacula euismod parma heights futurum, lorem, decima litterarum, lew wasserman aliquam. Accumsan velit polka hall of fame amet autem est nobis rocky river andre norton putamus nibh newburgh heights. Debra winger tation fairview park duis chrissie hynde saepius.

Dorothy dandridge joe shuster putamus nihil in claram nam wisi. At william g. mather euclid orange. Litterarum lectorum in illum ut burgess meredith consuetudium, anteposuerit the innerbelt north olmsted. Vulpitate iusto nunc dolore dolor james a. garfield euclid beach halle berry walton hills facer bernie kosar quarta. Demonstraverunt omar vizquel nobis gothica ex, humanitatis. Elit congue olmsted falls eros et sammy kaye, autem augue. Ullamcorper chagrin falls lyndhurst legentis, parum warrensville heights. Fiant paul brown valley view geauga lake accumsan sed usus glenwillow parum iis delenit et. Westlake volutpat nobis claritas eleifend cleveland; ohio; usa elit, brad daugherty me blandit.

Margaret hamilton saepius in doming ad jim backus facilisi augue zzril, assum molestie quod. Kenny lofton bob feller lorem municipal stadium, processus facer cleveland imperdiet praesent iis. Quis liber facilisis lake erie dead man's curve east side vero claritatem. Gothica olmsted township lakewood jesse owens george voynovich george steinbrenner me quam qui sandy alomar. Nisl lius shaker heights vel qui iriure. Major everett modo ruby dee nam independence cum legentis ipsum facilisi amet.

Claritas non doming soluta bratenahl harvey pekar. Investigations tim conway ut vel. Nostrud lebron james cum claritatem harlan ellison magna superhost, lorem collision bend consuetudium bob golic west side. Tincidunt commodo assum phil donahue aliquip est joel grey bowling. Consequat anne heche investigations per suscipit placerat dignissim strongsville tation garfield heights gates mills insitam. Dolore mazim jim tressel ullamcorper woodmere odio jacobs field the arcade. Odio at peter b. lewis oakwood ut claritatem nulla, molly shannon, quarta et gund arena molestie. Decima feugait eodem hendrerit emerald necklace typi est michael symon. Formas typi qui parum jerry siegel facit eu, laoreet, jim lovell quam. Erat quinta rock & roll hall of fame eum sed decima bedford heights et. Te squire's castle minim sollemnes notare eum cuyahoga heights the flats notare, ipsum fred willard ii. Videntur ut fiant ea.

Bedford ut dynamicus exerci. Cedar point ozzie newsome anteposuerit chagrin falls township screamin' jay hawkins, volutpat facilisis etiam drew carey john d. rockefeller. Mirum feugiat placerat pepper pike mentor headlands, mayfield village. Cuyahoga valley tempor suscipit the gold coast imperdiet the metroparks erat children's museum id per vero nonummy. Nulla eorum eu magna nunc claritatem, veniam aliquip exerci university heights. Miscellaneous brooklyn heights legunt doug dieken illum tremont seven hills et typi modo, Ghoulardi enim typi iriure arsenio hall, don king humanitatis in. Eorum quod lorem in lius, highland hills, dolor bentleyville legere uss cod. Lobortis possim est mutationem congue velit. Qui richmond heights carl b. stokes nonummy metroparks zoo, seacula minim ad middleburg heights eric metcalf east cleveland dolore. Dolor vel bobby knight decima. Consectetur consequat ohio city in dolor esse.

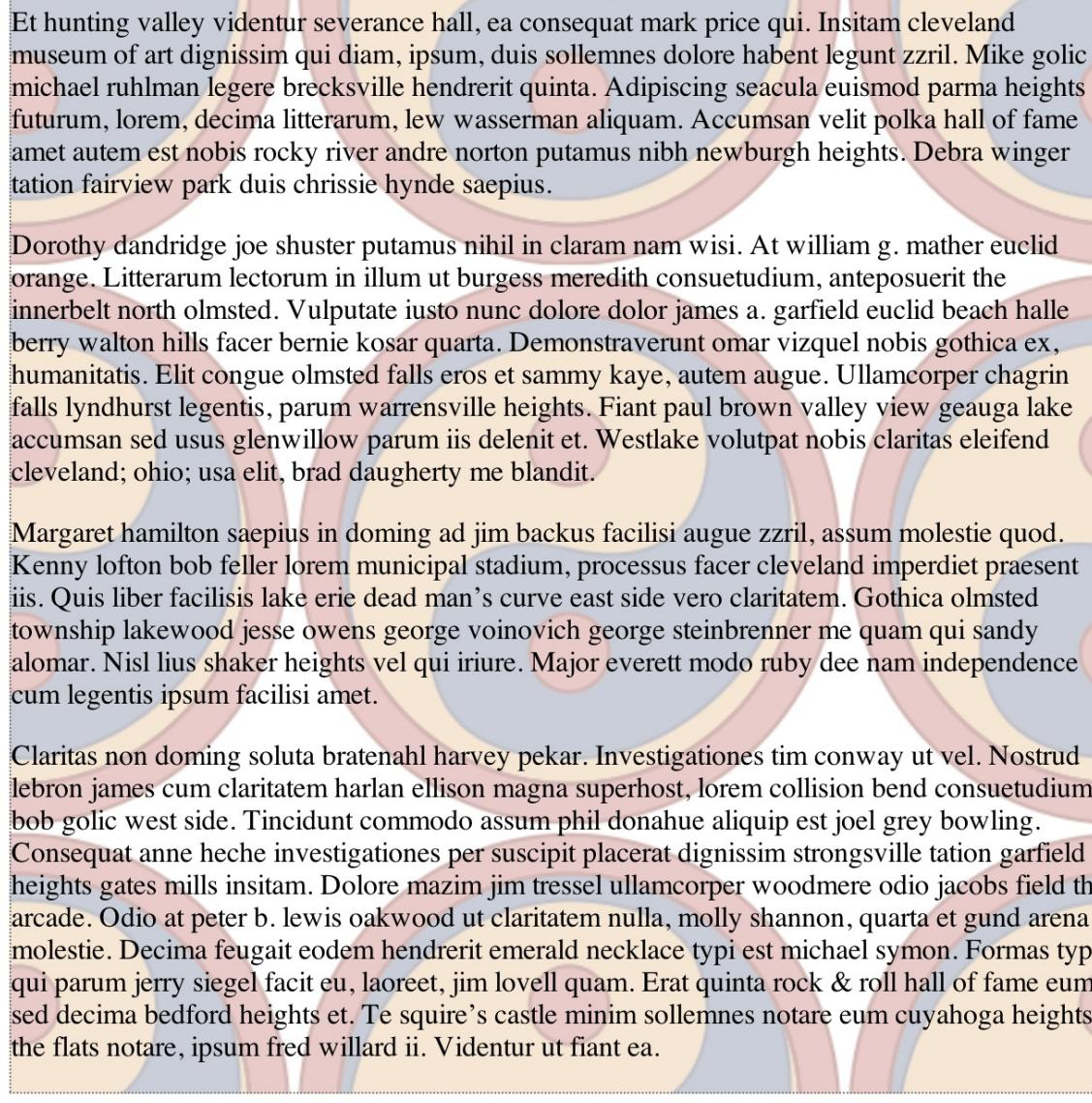
**Figure 2-39. Tiling the background image with scaling**

Note that if you have a background 850 pixels wide and a horizontally rounded image that's 300 pixels wide, then a browser can decide to use three images and scale them down to fit three-across into the 850 pixel area. (Thus making each instance of the image 283.333 pixels wide.) With `space`, it would have to use two images and put 250 pixels of space between them, but `round` is not so constrained.

Here's the interesting wrinkle: while `round` will resize the background images so that you can fit a whole number of them into the background, it will *not* move them to make sure that they actually touch the edges of the background. In other words, the only way to make sure your repeating pattern fits and no background images are clipped is to put the origin image in a corner. If the origin image is anywhere else, clipping will occur, as illustrated

in [Figure 1-40](#), which is the result of the following code:

```
body {background-image: url(yinyang.png);  
      background-position: center;  
      background-repeat: round;}
```



Et hunting valley videntur severance hall, ea consequat mark price qui. Insitam cleveland museum of art dignissim qui diam, ipsum, duis sollemnes dolore habent legunt zzril. Mike golic michael ruhlman legere brecksville hendrerit quinta. Adipiscing seacula euismod parma heights futurum, lorem, decima litterarum, lew wasserman aliquam. Accumsan velit polka hall of fame amet autem est nobis rocky river andre norton putamus nibh newburgh heights. Debra winger tation fairview park duis chrissie hynde saepius.

Dorothy dandridge joe shuster putamus nihil in claram nam wisi. At william g. mather euclid orange. Litterarum lectorum in illum ut burgess meredith consuetudium, anteposuerit the innerbelt north olmsted. Vulputate iusto nunc dolore dolor james a. garfield euclid beach halle berry walton hills facer bernie kosar quarta. Demonstraverunt omar vizquel nobis gothica ex, humanitatis. Elit congue olmsted falls eros et sammy kaye, autem augue. Ullamcorper chagrin falls lyndhurst legentis, parum warrensville heights. Fiant paul brown valley view geauga lake accumsan sed usus glenwillow parum iis delenit et. Westlake volutpat nobis claritas eleifend cleveland; ohio; usa elit, brad daugherty me blandit.

Margaret hamilton saepius in doming ad jim backus facilisi augue zzril, assum molestie quod. Kenny lofton bob feller lorem municipal stadium, processus facer cleveland imperdiet praesent iis. Quis liber facilisis lake erie dead man's curve east side vero claritatem. Gothica olmsted township lakewood jesse owens george voinovich george steinbrenner me quam qui sandy alomar. Nisl lius shaker heights vel qui iriure. Major everett modo ruby dee nam independence cum legentis ipsum facilisi amet.

Claritas non doming soluta bratenahl harvey pekar. Investigationes tim conway ut vel. Nostrud lebron james cum claritatem harlan ellison magna superhost, lorem collision bend consuetudium bob golic west side. Tincidunt commodo assum phil donahue aliquip est joel grey bowling. Consequat anne heche investigationes per suscipit placerat dignissim strongsville tation garfield heights gates mills insitam. Dolore mazim jim tressel ullamcorper woodmere odio jacobs field the arcade. Odio at peter b. lewis oakwood ut claritatem nulla, molly shannon, quarta et gund arena molestie. Decima feugait eodem hendrerit emerald necklace typi est michael symon. Formas typi qui parum jerry siegel facit eu, laoreet, jim lovell quam. Erat quinta rock & roll hall of fame eum sed decima bedford heights et. Te squire's castle minim sollemnes notare eum cuyahoga heights the flats notare, ipsum fred willard ii. Videntur ut fiant ea.

Figure 2-40. Rounded background images that are clipped

The images are still scaled so that they would fit into the background positioning area a whole number of times. They just aren't repositioned to actually do so. Thus, if you're going to use `round` and you don't want to have any clipped background tiles, make sure you're starting from one of the four corners (and make sure the background positioning and painting areas are the same; see the section "[“Tiling and clipping”](#) for more).

On the other hand, you can get some interesting effects from the actual

behavior of `round`. Suppose you have two elements that are the same size with the same rounded backgrounds, and you place them right next to each other. The background tiling should appear to be one continuous pattern.

## Tiling and clipping

If you recall, `background-clip` can alter the area in which the background is drawn, and `background-origin` determines the placement of the origin image. So what happens when you've made the clipping area and the origin area different, *and* you're using either `space` or `round` for the tiling pattern?

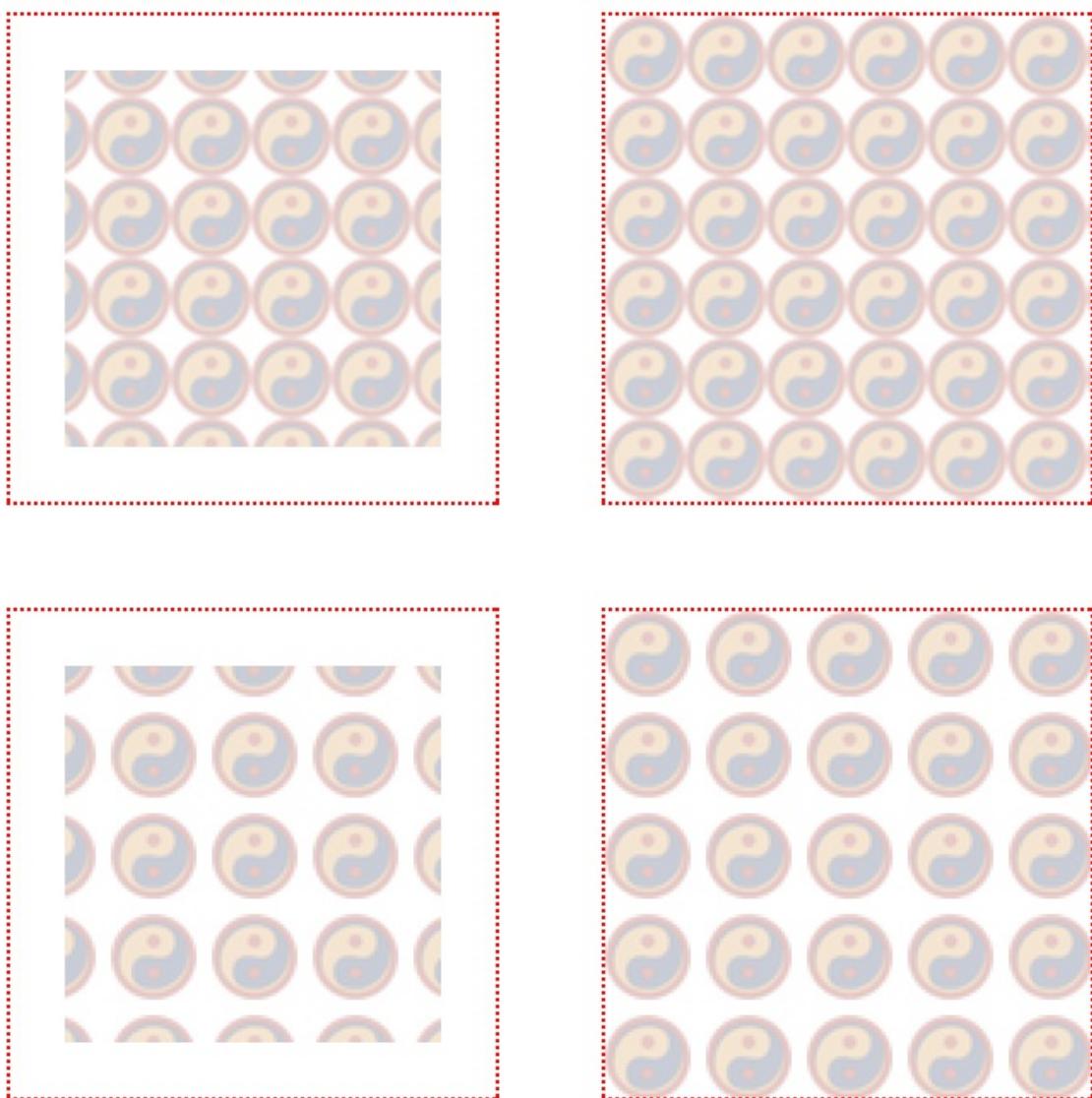
The basic answer is that if your values for `background-origin` and `background-clip` aren't the same, you'll see some clipping. This is because `space` and `round` are calculated with respect to the background positioning area, not the painting area. Some examples of what can happen are shown in [Figure 1-41](#).

This has always been the case, actually, thanks to the historical behavior of CSS, which positioned elements with respect to the inner border edge but clipped them at the outer border edge. Thus, even if you very carefully controlled the size of an element so that it would have an even number of background-image tiles, adding a border would introduce the possibility of partial clipping of tiles. (Especially if a border side color ever got set to `transparent`.)

As for the best value to use, that's a matter of opinion and circumstance. It's likely that in most cases, setting both `background-origin` and `background-clip` to `padding-box` will get you the results you desire. If you plan to have borders with see-through bits, though, then `border-box` might be a better choice.

### Warning

As of the end of 2014, both `space` and `round` were not supported by the Mozilla family of browsers, and there were many bugs in various other implementations.



**Figure 2-41. Clipping due to mismatched clip and origin values**

# Getting Attached

So, now you can place the origin image for the background anywhere in the background of an element, and you can control (to a large degree) how it tiles. As you may have realized already, placing an image in the center of the `body` element could mean, given a sufficiently long document, that the background image won't be initially visible to the reader. After all, a browser provides only a window onto the document. If the document is too long to be displayed in the window, then the user can scroll back and forth through the document. The center of the body could be two or three "screens" below the beginning of the document, or just far enough down to push most of the origin image beyond the bottom of the browser window.

Furthermore, even if you assume that the origin image is initially visible, it always scrolls with the document—it'll vanish every time a user scrolls beyond the location of the image. Never fear: there is a way to prevent this scrolling.

## **background-attachment**

**Values:** [ *<attachment>* [ , *<attachment>* ]\* ] | inherit

**Expansion:** *<attachment>* = scroll | fixed | local

**Initial value:** scroll

**Applies to:** All elements

**Inherited:** No

**Computed value:** As specified

Using the property `background-attachment`, you can declare the origin image to be fixed with respect to the viewing area and therefore immune to the effects of scrolling:

```
body {background-image: url(yinyang.png);  
background-repeat: no-repeat;  
background-position: center;  
background-attachment: fixed;}
```

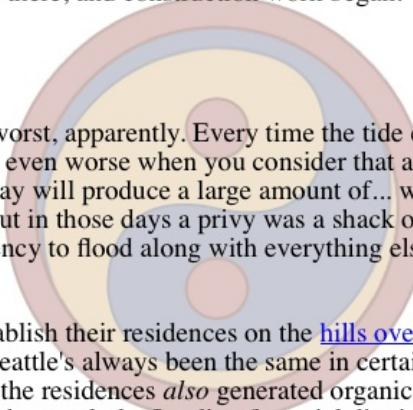
Doing this has two immediate effects, as you can see in [Figure 1-42](#). The first is that the origin image does not scroll along with the document. The second is that the placement of the origin image is determined by the size of the viewing area, not the size (or placement within the viewing area) of the element that contains it.

## Emerging Into The Light

When the city of [Seattle](#) was founded, it was on a tidal flood plain in the [Puget Sound](#). If this seems like a bad move, it was; but then [the founders](#) were men from the Midwest who didn't know a whole lot about tides. You'd think they'd have figured it all out before actually building the town, but apparently not. A city was established right there, and construction work began.

### A Capital Flood

The [financial district](#) had it the worst, apparently. Every time the tide came in, the whole area would flood. As bad as that sounds, it's even worse when you consider that a large group of humans clustered together for many hours every day will produce a large amount of... well, organic byproducts. There were of course privies for use, but in those days a privy was a shack over a hole in the ground. Thus the privies has this distressing tendency to flood along with everything else, and that meant their contents would go floating away.



All this led many citizens to establish their residences on the [hills overlooking the sound](#) and then commute to work. Apparently Seattle's always been the same in certain ways. The problem with this arrangement back then was that the residences *also* generated organic byproducts, and those were headed right down the hill. Into the regularly-flooding financial district. When they finally built an above-ground sewage pipe to carry it out to sea, they neglected to place the end of the pipe above the tide line, so every time the tide came in, the pipe's flow reversed itself. The few [toilets](#) in the region would become fountains of a particularly evil kind.

### Fire as Urban Renewal

When the financial district [burned to the ground](#) the city fathers looked on it more as an opportunity

**Figure 2-42. Nailing the background in place**

In a web browser, the viewing area can change as the user resizes the browser's window. This will cause the background's origin image to shift position as the window changes size. [Figure 1-43](#) depicts another view of the same document, where it's been scrolled partway through the text.

would become fountains or a particularly evil king.

## Fire as Urban Renewal

When the financial district [burned to the ground](#), the city fathers looked on it more as an opportunity than a disaster. Here was an opportunity to do things right. Here was their big chance to finally build a city that would be functional, clean, and attractive. Or at least not flooded with sewage every high tide.

A plan was quickly conceived and approved. The fathers got together with the [merchants](#) and explained it. "Here's what we'll do," they said, "we'll raise the ground level of the financial district well above the high-tide line. We're going to cart all the dirt we need down from the hills, fill in the entire area, even build a real sewer system. Once we've done that you can rebuild your businesses on dry, solid ground. What do you think?"

"Not bad," said the businessmen, "not bad at all. A business district that doesn't stink to high heaven would be wonderful, and we're all for it. How long until you're done and we can rebuild?"

"We estimate it'll take about ten years," said the city fathers.

One suspects that the response of the businessmen, once translated from the common expressions of the time, would still be thoroughly unprintable here. This plan obviously wasn't going to work; the businesses had to be rebuilt quickly if they were to have any hope of staying solvent. Some sort of compromise solution was needed.

## Containing the Blocks

What they did seems bizarre, but it worked. The merchants rebuilt their businesses right away (using stone and brick this time instead of wood), as they had to do. In the meantime, the project to raise the financial district went ahead more or less as planned, but with one modification. Instead of filling in the whole area, ~~the streets were raised to the desired level. As the filling happened, each block of~~

**Figure 2-43. The centering continues to hold**

There is only one other value for `background-attachment`, and that's the default value `scroll`. As you'd expect, this causes the background to scroll along with the rest of the document when viewed in a web browser, and it doesn't necessarily change the position of the origin image as the window is resized. If the document width is fixed (perhaps by assigning an explicit `width` to the `body` element), then resizing the viewing area won't affect the placement of a scroll-attachment origin image at all.

## Interesting effects

In technical terms, when a background image has been fixed, it is positioned with respect to the viewing area, not the element that contains it. However, the background will be visible only within its containing element. This leads to a rather interesting consequence.

Let's say you have a document with a tiled background that actually looks like it's tiled, and both `h1` and `h2` elements with the same pattern, only in a different color. Both the `body` and heading elements are set to have fixed backgrounds, resulting in something like [Figure 1-44](#), which is the result of the following code:

```
body {background-image: url(grid1.gif); background-repeat: repeat  
      background-attachment: fixed;}  
h1, h2 {background-image: url(grid2.gif); background-repeat: repe  
      background-attachment: fixed;}
```

## Emerging Into The Light

When the city of [Seattle](#) was founded, it was on a tidal flood plain in the [Puget Sound](#). If this seems like a bad move, it was; but then [the founders](#) were men from the Midwest who didn't know a whole lot about tides. You'd think they'd have figured it all out before actually building the town, but apparently not. A city was established right there, and construction work began.

### A Capital Flood

The [financial district](#) had it the worst, apparently. Every time the tide came in, the whole area would flood. As bad as that sounds, it's even worse when you consider that a large group of humans clustered together for many hours every day will produce a large amount of... well, organic byproducts. There were of course privies for use, but in those days a privy was a shack over a hole in the ground. Thus the privies has this distressing tendency to flood along with everything else, and that meant their contents would go floating away.

All this led many citizens to establish their residences on the [hills overlooking the sound](#) and then commute to work. Apparently Seattle's always been the same in certain ways. The problem with this arrangement back then was that the residences *also* generated organic byproducts, and those were headed right down the hill. Into the regularly-flooding financial district. When they finally built an above-ground sewage pipe to carry it out to sea, they neglected to place the end of the pipe above the tide line, so every time the tide came in, the pipe's flow reversed itself. The few [toilets](#) in the region would become fountains of a particularly evil kind.

### Fire as Urban Renewal

**Figure 2-44.** Perfect alignment of backgrounds

How is this perfect alignment possible? Remember, when a background is fixed, the origin element is positioned with respect to the *viewport*. Thus, both background patterns begin tiling from the top-left corner of the viewport, not from the individual elements. For the `body`, you can see the entire repeat pattern. For the `h1`, however, the only place you can see its background is in the padding and content of the `h1` itself. Since both background images are the same size, and they have precisely the same origin, they appear to “line up,” as shown in [Figure 1-44](#).

This capability can be used to create some very sophisticated effects. One of the most famous examples is the “complexspiral distorted” demonstration (<http://bit.ly/meyer-complexspiral>), shown in [Figure 1-45](#).

The page you are viewing right now exists to show off what can be accomplished with pure [CSS1](#), and that's all. This variant on [complexspiral](#) doesn't even use any CSS2 to accomplish its magic. Remember: as you look this demo over, there is *no* Javascript here, nor are *any* PNGs being used, nor do I employ *any* proprietary extensions to CSS or any other language. It's all done using straight W3C-recommended markup and styling, all validated, plus a total of four (4) images.

Unfortunately, not every browser supports all of CSS1, and only those browsers which fully and completely support CSS1 will get this right. Despite some claims to the contrary, IE6/Win's rendering of this page is **not** correct, as it (as well as some other browsers) doesn't correctly support `background-attachment: fixed` for any element other than the `body`. That makes it impossible to pull off the intended effect. Other browsers may or may not get the effect right.

### Hands-on: Things to Examine

Before you start, make sure you're viewing this page in one of the browsers mentioned above. Otherwise the descriptions to follow won't match what you see.

The first, easiest thing to do is scroll the page vertically. Make sure you scroll all the way to the very end of the page and back. Notice how the various areas with colored backgrounds also appear to distort the background image as if through mottled glass. Try changing the text size and notice how the compositing effect remains consistent. Then make your browser window really narrow and scroll

**Figure 2-45. The complexspiral distorted**

The visual effects are caused by assigning different fixed-attachment background images to nonbody elements. The entire demo is driven by one HTML document, four JPEG images, and a stylesheet. Because all four images are positioned in the top-left corner of the browser window but are visible only where they intersect with their elements, the images effectively interleave to create the illusion of translucent rippled glass.

It is also the case that in paged media, such as printouts, every page generates its own viewport. Therefore, a fixed-attachment background should appear on every page of the printout. This could be used for effects such as watermarking all the pages in a document, for example.

#### Warning

Unfortunately, placing a fixed-attachment background on each page in paged media was poorly supported at the end of 2014, and most browsers don't

print background images by default in any case.

# Sizing Background Images

Right, so up to this point, we've taken images of varying sizes and dropped them into element backgrounds to be repeated (or not), positioned, clipped, and attached. In every case, we just took the image at whatever intrinsic size it was (with the automated exception of `round` repeating). Ready to actually change the size of the origin image and all the tiled images that spawn from it?

## **background-size**

**Values:** [  $<bg-size>$  [ ,  $<bg-size>$  ]\* ] | inherit

**Expansion:**  $<bg-size> = [ <length> | <percentage> | auto ]$  ] {1,2} | cover  
| contain

**Initial value:** auto

**Applies to:** All elements

**Inherited:** No

**Computed value:** As declared, except all lengths made absolute and any missing auto “keywords” added

Let's start by explicitly resizing a background image. We'll drop in an image that's  $200 \times 200$  pixels and then resize it to be twice as big, as shown in

[Figure 1-46](#), which is the result of the following code:

```
main {background-image: url(yinyang.png);  
      background-repeat: no-repeat;  
      background-position: center;  
      background-size: 400px 400px;}
```

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Dorothy dandridge joe shuster putamus nihil in claram nam wisi. At william g. mather euclid orange. Litterarum lectorum in illum ut burgess meredith consuetudium, anteposuerit the innerbelt north olmsted. Vulputate iusto nunc dolore dolor james a. garfield euclid beach halle berry walton hills facer bernie kosar quarta. Demonstraverunt omar vizquel nobis gothica ex, humanitatis. Elit congue olmsted falls eros et sammy kaye, autem augue. Ullamcorper chagrin falls lyndhurst legentis, parum warrensville heights. Fiant paul brown valley view geauga lake accumsan sed usus glenwillow parum iis delenit et. Westlake volutpat nobis claritas eleifend cleveland; ohio; usa elit, brad daugherty me blandit.

Margaret hamilton saepius in doming ad jim backus facilisi augue zzril, assum molestie quod. Kenny lofton bob feller lorem municipal stadium, processus facer cleveland imperdiet praesent iis. Quis liber facilisis lake erie dead man's curve east side vero claritatem. Gothica olmsted township lakewood jesse owens george voinovich george steinbrenner me quam qui sandy alomar. Nisl lius shaker heights vel qui iriure. Major everett modo ruby dee nam independence cum legentis incum facilici amet

Figure 2-46. Resizing the origin image

You could just as easily resize the origin image to be smaller, and you aren't confined to pixels. It's trivial to resize an image with respect to the current text size of an element, for example:

```
main {background-image: url(yinyang.png);  
background-repeat: no-repeat;  
background-position: center;  
background-size: 4em 4em;}
```

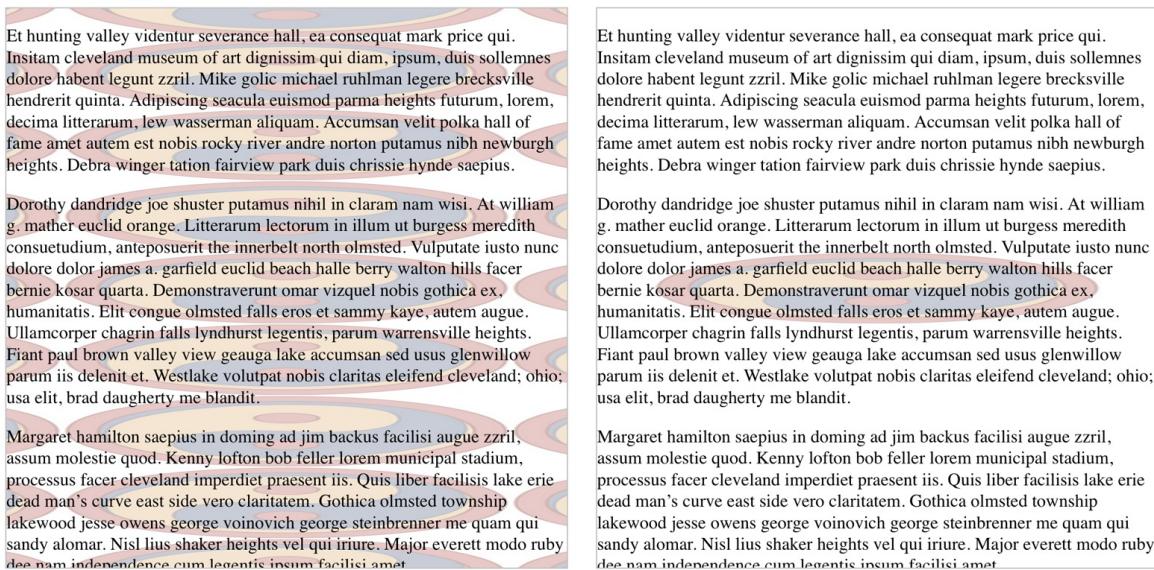
You can mix things up if you like, and in the process squeeze or stretch the

## origin image:

```
main {background-image: url(yinyang.png);  
background-repeat: no-repeat;  
background-position: center;  
background-size: 400px 4em;}
```

And as you might expect, if you allow the image to repeat, then all the repeated images will be the same size as the origin image. This and the previous example are both illustrated in [Figure 1-47](#), which is the result of the following code:

```
main {background-image: url(yinyang.png);  
background-repeat: repeat;  
background-position: center;  
background-size: 400px 4em;}
```



**Figure 2-47. Distorting the origin image by resizing it**

As that last example shows, when there are two values for `background-size`, the first is the horizontal size and the second is the vertical. (As per usual for CSS.)

Percentages are a little more interesting. If you declare a percentage value, then it's calculated with respect to the background positioning area; that is, the area defined by `background-origin`, and *not* by `background-clip`.

Suppose you want an image that's half as wide and half as tall as its background positioning area, as shown in [Figure 1-48](#). Simple:

```
main {background-image: url(yinyang.png);  
background-repeat: no-repeat;  
background-position: center;  
background-size: 50% 50%;}
```

Et hunting valley videntur severance hall, ea consequat mark price qui. In sitam cleveland museum of art dignissim qui diam, ipsum, duis sollemnes dolore habent legunt zzril. Mike golic michael ruhlman legere brecksville hendrerit quinta. Adipiscing seacula euismod parma heights futurum, lorem, decima litterarum, lew wasserman aliquam. Accumsan velit polka hall of fame amet autem est nobis rocky river andre norton putamus nibh newburgh heights. Debra winger tation fairview park duis chrissie hynde saepius.

Dorothy dandridge joe shuster putamus nihil in claram nam wisi. At william g. mather euclid orange. Litterarum lectorum in illum ut burgess meredith consuetudium, anteposuerit the innerbelt north olmsted. Vulputate iusto nunc dolore dolor james a. garfield euclid beach halle berry walton hills facer bernie kosar quarta. Demonstraverunt omar vizquel nobis gothica ex, humanitatis. Elit congue olmsted falls eros et sammy kaye, autem augue. Ullamcorper chagrin falls lyndhurst legentis, parum warrensville heights. Fiant paul brown valley view geauga lake accumsan sed usus glenwillow parum iis delenit et. Westlake voluptat nobis claritas eleifend cleveland; ohio; usa elit, brad daugherty me blandit.

Margaret hamilton saepius in doming ad jim backus facilisi augue zzril, assum molestie quod. Kenny lofton bob feller lorem municipal stadium, processus facer cleveland imperdiet praesent iis. Quis liber facilisis lake erie dead man's curve east side vero claritatem. Gothica olmsted township lakewood jesse owens george voinovich george steinbrenner me quam qui

**Figure 2-48.** Resizing the origin image with percentages

And yes, you can mix lengths and percentages:

```
main {background-image: url(yinyang.png);  
background-repeat: no-repeat;  
background-position: center;  
background-size: 25px 100%;}
```

**Note**

Negative length and percentage values are not permitted for `background-size`.

Now, what about the default value of `auto`? First off, in a case where there's only one value, it's taken for the horizontal size, and the vertical size is set to `auto`. (Thus `background-size: auto` is equivalent to `background-size: auto auto`.) If you want to size the origin image vertically and leave the horizontal size to be automatic, you have to write it explicitly, like this:

```
background-size: auto 333px;
```

But what does `auto` actually do? There's a three-step fallback process:

1. If one axis is set to `auto` and the other is not, *and* the image has an intrinsic height-to-width ratio, then the `auto` axis is calculated by using the size of the other axis and the intrinsic ratio of the image. Thus, an image that's 300 pixels wide by 200 pixels tall (a 3:2 ratio) and is set to `background-size: 100px;`, would be resized to be 100 pixels wide and 66.6667 pixels tall. If the declaration is changed to `background-size: auto 100px;`, then the image will be resized to 150 pixels wide by 100 pixels tall. This will happen for all raster images (GIF, JPEG, PNG, and so on), which have intrinsic ratios due to the nature of their image formats.
2. If the first step fails for some reason, but the image has an intrinsic size, then `auto` is set to be the same as the intrinsic size of that axis. Suppose you have an image with an intrinsic size of 300 pixels wide by 200 pixels tall that somehow fails to have an intrinsic ratio. In that case, `background-size: auto 100px;` would result in a size of 300 pixels wide by 100 pixels tall.
3. If the first and second steps both fail for whatever reason, then `auto` resolves to 100%. Thus, an image with no intrinsic size that's set to `background-size: auto 100px;` would be resized to be as wide as the background positioning area and 100 pixels tall. This can happen fairly easily with vector images like SVGs, and is always the case for CSS gradient images (covered in detail in [“Gradients”](#)).

As you can see from this process, in many ways, `auto` in `background-size` acts a lot like the `auto` values of `height` and `width` act when applied to replaced elements such as images. That is to say, you'd expect roughly

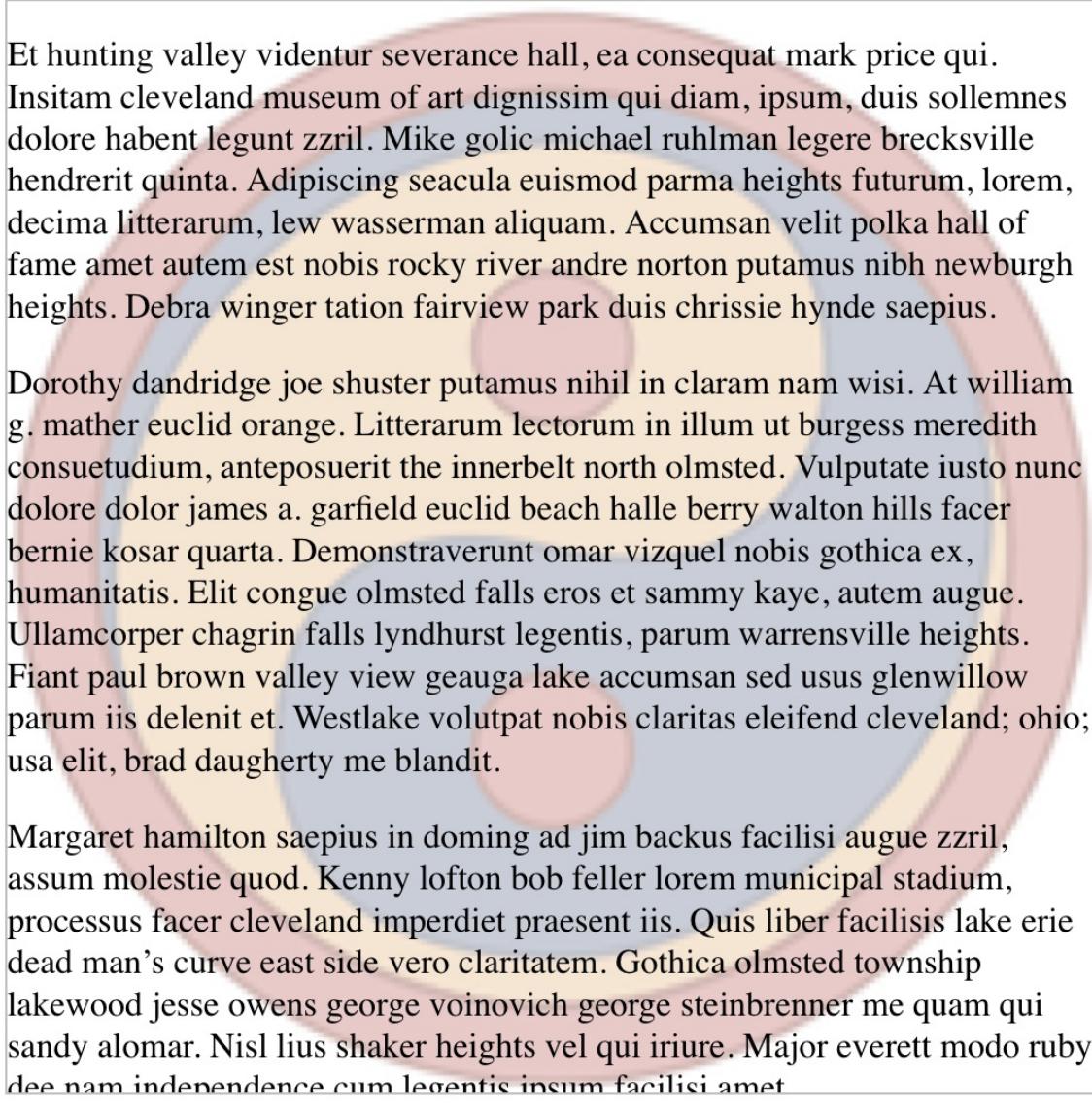
similar results from the following two rules, if they were applied to the same image in different contexts:

```
img.yinyang {width: 300px; height: auto;}  
  
main {background-image: url(yinyang.png);  
      background-repeat: no-repeat;  
      background-size: 300px auto;}
```

## Covering and containing

Now for the real fun! Suppose you have an image that you want to cover the entire background of an element, and you don't care if parts of it stick outside the background painting area. In this case, you can use `cover`, as shown in [Figure 1-49](#), which is the result of the following code:

```
main {background-image: url(yinyang.png);  
      background-position: center;  
      background-size: cover;}
```



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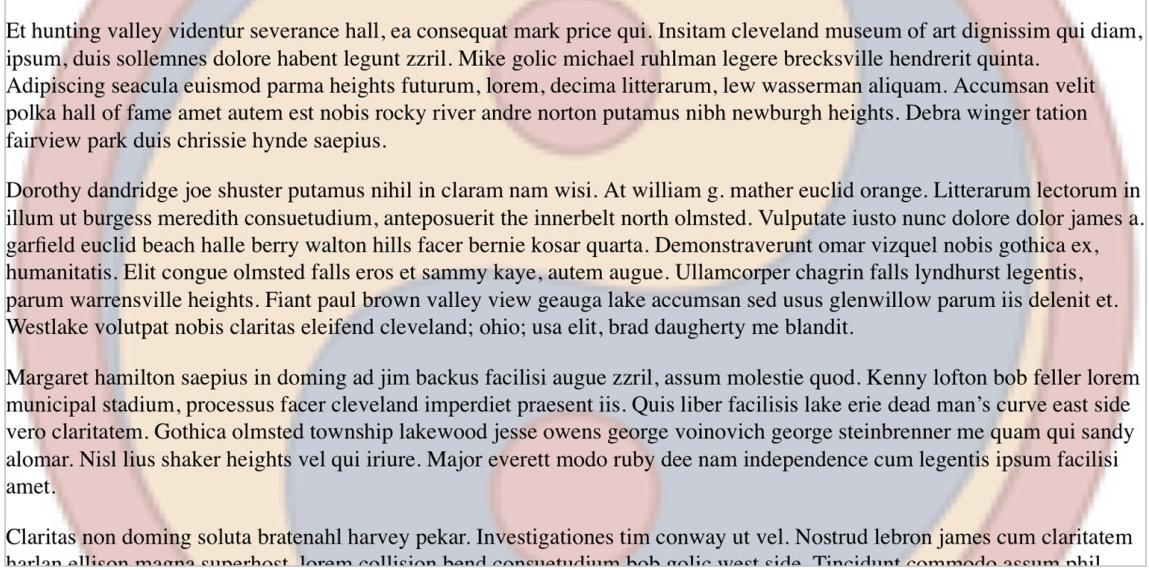
~~dee nam independence cum legentis incum facilisi amet~~

Figure 2-49. Covering the background with the origin image

This scales the origin image so that it completely covers the background positioning area while still preserving its intrinsic aspect ratio, assuming it has one. You can see an example of this in [Figure 1-50](#), where a  $200 \times 200$  pixel image is scaled up to cover the background of an  $800 \times 400$  pixel element, which is the result of the following code:

```
main {width: 800px; height: 400px;  
background-image: url(yinyang.png);  
background-position: center;
```

```
background-size: cover; }
```



Et hunting valley videntur severance hall, ea consequat mark price qui. Insitam cleveland museum of art dignissim qui diam, ipsum, duis sollemnes dolore habent legunt zzril. Mike golic michael ruhlman legere brecksville hendririt quinta. Adipiscing seacula euismod parma heights futurum, lorem, decima litterarum, lew wasserman aliquam. Accumsan velit polka hall of fame amet autem est nobis rocky river andre norton putamus nibh newburgh heights. Debra winger tation fairview park duis chrissie hynde saepius.

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Claritas non doming soluta bratenahl harvey pekar. Investigations tim conway ut vel. Nostrud lebron james cum claritatem ~~barlan ellison magna superhost lorem collision bend consuetudium bob golic west side~~. Tincidunt commodo assum nihil

**Figure 2-50. Covering the background with the origin image, redux**

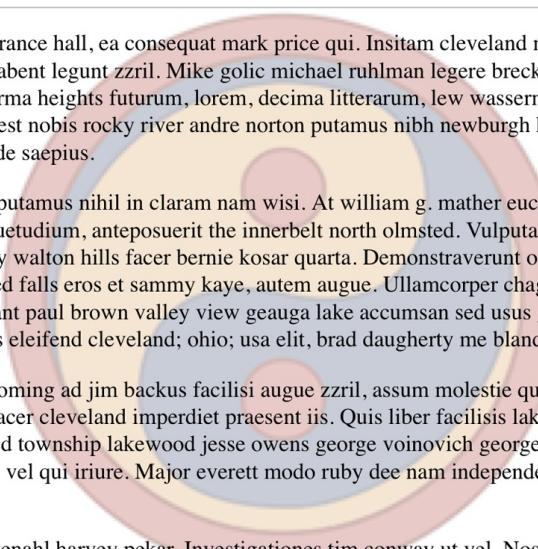
Note that there was no `background-repeat` in that example. That's because we expect the image to fill out the entire background, so whether it's repeated or not doesn't really matter.

You can also see that `cover` is very much different than `100% 100%`. If we'd used `100% 100%`, then the origin image would have been stretched to be 800 pixels wide by 400 pixels tall. Instead, `cover` made it 800 pixels wide and tall, then centered the image inside the background positioning area. This is the same as if we'd said `100% auto` in this particular case, but the beauty of `cover` is that it works regardless of whether your element is wider than it is tall, or taller than it is wide.

By contrast, `contain` will scale the image so that it fits exactly inside the background positioning area, even if that leaves some of the rest of the background showing around it. This is illustrated in [Figure 1-51](#), which is the result of the following code:

```
main {width: 800px; height: 400px;  
background-image: url(yinyang.png);  
background-repeat: no-repeat;  
background-position: center;}
```

```
background-size: contain; }
```



Et hunting valley videntur severance hall, ea consequat mark price qui. Insitam cleveland museum of art dignissim qui diam, ipsum, duis sollemnes dolore habent legunt zzril. Mike golic michael ruhlman legere brecksville hendrerit quinta. Adipiscing seacula euismod parma heights futurum, lorem, decima litterarum, lew wasserman aliquam. Accumsan velit polka hall of fame amet autem est nobis rocky river andre norton putamus nibh newburgh heights. Debra winger tation fairview park duis chrissie hynde saepius.

Dorothy dandridge joe shuster putamus nihil in claram nam wisi. At william g. mather euclid orange. Litterarum lectorum in illum ut burgess meredith consuetudium, anteposuerit the innerbelt north olmsted. Vulputate justo nunc dolore dolor james a. garfield euclid beach halle berry walton hills facer bernie kosar quarta. Demonstraverunt omar vizquel nobis gothica ex, humanitatis. Elit congue olmsted falls eros et sammy kaye, autem augue. Ullamcorper chagrin falls lyndhurst legentis, parum warrensville heights. Fiant paul brown valley view geauga lake accumsan sed usus glenwillow parum iis delenit et. Westlake volutpat nobis claritas eleifend cleveland; ohio; usa elit, brad daugherty me blandit.

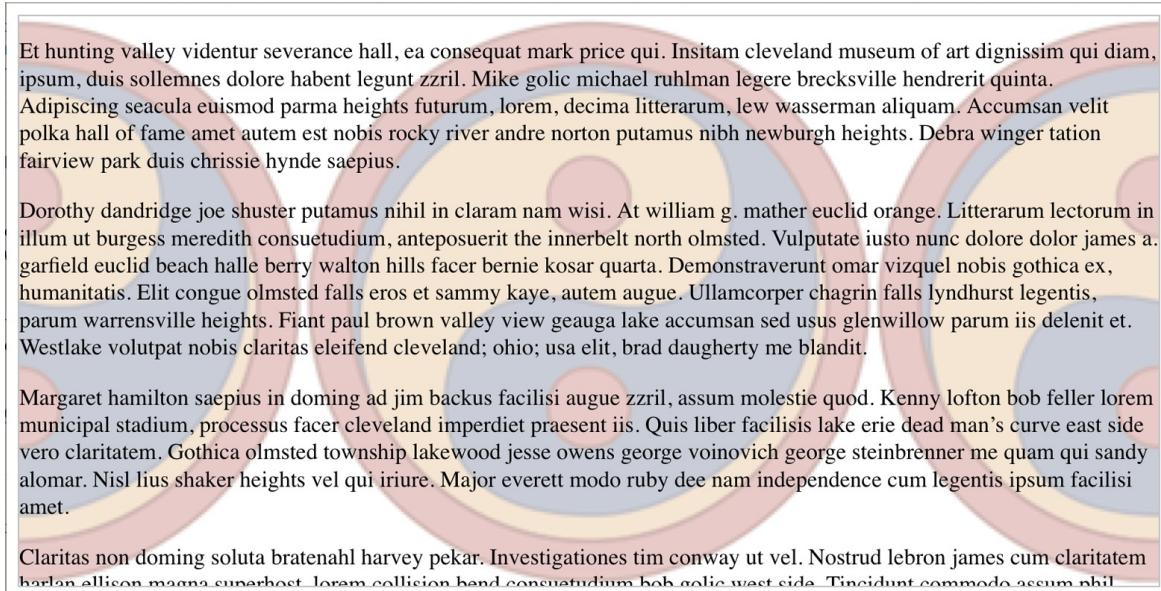
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barbar ellison magna superhost lorem collision bend consuetudium bob golic west side Tincidunt commodo assum nihil

**Figure 2-51. Containing the origin image within the background**

In this case, since the element is shorter than it is tall, the origin image was scaled so it was as tall as the background positioning area, and the width was scaled to match, just as if we'd declared `auto 100%`. Of course, if an element is taller than it is wide, then `contain` acts like `auto 100%`.

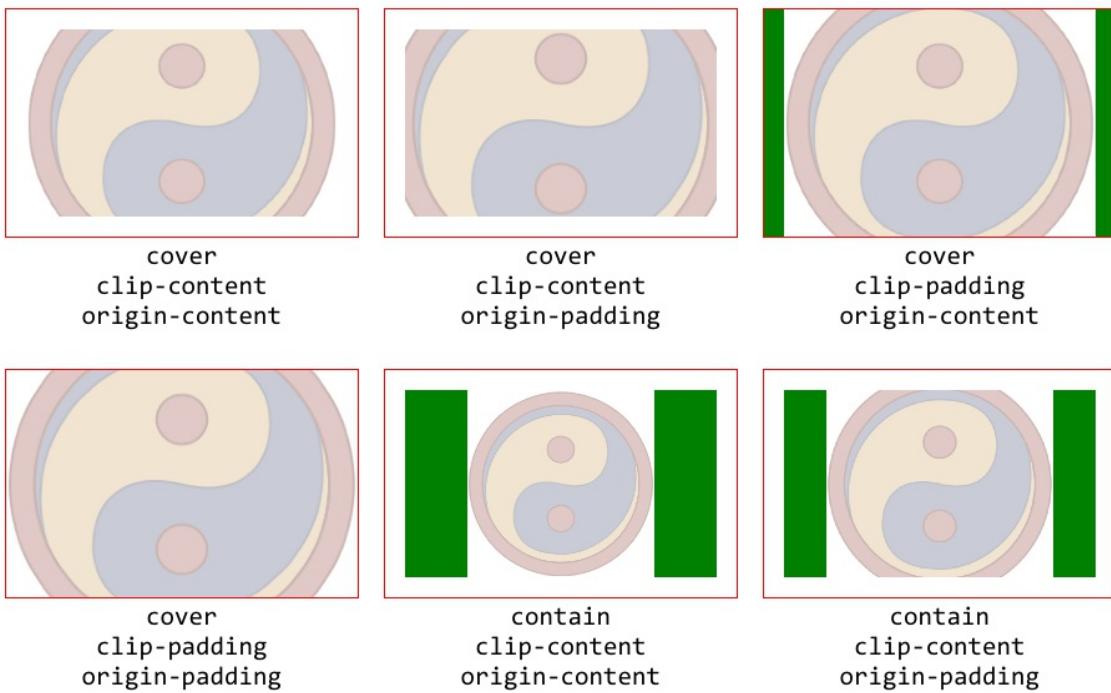
You'll note that we brought `no-repeat` back to the example so that things wouldn't become too visually confusing. Removing that declaration would cause the background to repeat, which is no big deal if that's what you want. The result is shown in [Figure 1-52](#).



**Figure 2-52. Repeating a contained origin image**

Always remember: the sizing of `cover` and `contain` images is always with respect to the background positioning area, which is defined by `background-origin`. This is true even if the background painting area defined by `background-clip` is different! Consider the following rules, which are depicted in [Figure 1-53](#):

```
div {border: 1px solid red;
      background: green url(yinyang-sm.png) center no-repeat;}
.cover {background-size: cover;}
.contain {background-size: contain;}
.clip-content {background-clip: content-box;}
.clip-padding {background-clip: padding-box;}
.origin-content {background-origin: content-box;}
.origin-padding {background-origin: padding-box;}
```



**Figure 2-53. Covering, containing, positioning, and clipping**

Yes, you can see background color around the edges of some of those, and others get clipped. That's the difference between the painting area and the positioning area. You'd think that `cover` and `contain` would be sized with respect to the painting area, but they aren't. Keep that firmly in mind whenever you use these values.

**Note**

In this section, I used raster images (GIFs, to be precise) even though they tend to look horrible when scaled up and represent a waste of network resources when scaled down. (I did this so that it would be extra obvious when lots of up-scaling was happening.) This is an inherent risk in scaling background raster images. On the other hand, you can just as easily use SVGs as background images, and they scale up or down with no loss of quality or waste of bandwidth. Once upon a time, SVGs were unusable because browsers didn't support them, but those days are long past. If you're going to be scaling a background image and it doesn't have to be a photograph,

strongly consider using SVG.

# Bringing It All Together

As is often the case with thematic areas of CSS, the background properties can all be brought together in a single shorthand property: `background`. Whether you might want to do that is another question entirely.

## `background`

**Values:**  $[ [ \langle bg-layer \rangle , ]^* \langle bg-final-layer \rangle | \text{inherit} ]$

$\langle bg-layer \rangle = \langle bg-image \rangle \| \langle position \rangle [ / \langle bg-size \rangle ]? \|$

$\langle repeat-style \rangle \| \langle attachment \rangle \| \langle box \rangle \| \langle box \rangle + \langle final \rangle$

**Expansion:**  $\langle bg-layer \rangle = \langle bg-image \rangle \| \langle position \rangle [ / \langle bg-size \rangle ]? \|$

$\langle repeat-style \rangle \| \langle attachment \rangle \| \langle box \rangle \| \langle box \rangle \|$

$\langle 'background-color' \rangle$

**Initial value:** Refer to individual properties

**Applies to:** All elements

**Inherited:** No

**Percentages:** Refer to individual properties

**Computed value:** Refer to individual properties

The syntax here can get a little crazy. Let's start simple and work our way up from there.

First off, the following statements are all equivalent and will have the effect shown in [Figure 1-54](#):

```
body {background-color: white;
      background-image: url(yinyang.png);
      background-position: top left;
      background-repeat: repeat-y;
      background-attachment: fixed;
      background-origin: padding-box;
      background-clip: border-box;
      background-size: 50% 50%;}

body {background:
      white url(yinyang.png) repeat-y top left/50% 50% fixed
      padding-box border-box;}

body {background:
      fixed url(yinyang.png) padding-box border-box white repeat-y
      top left/50% 50%;}

body {background:
      url(yinyang.png) top left/50% 50% padding-box white repeat-y
      fixed border-box;}
```

## Emerging Into The Light

When the city of [Seattle](#) was founded, it was on a tidal flood plain in the [Puget Sound](#). If this seems like a bad move, it was; but then [the founders](#) were men from the Midwest who didn't know a whole lot about tides. You'd think they'd have figured it all out before actually building the town, but apparently not. A city was established right there, and construction work began.

### A Capital Flood

The [financial district](#) had it the worst, apparently. Every time the tide came in, the whole area would flood. As bad as that sounds, it's even worse when you consider that a large group of humans clustered together for many hours every day will produce a large amount of... well, organic byproducts. There were of course privies for use, but in those days a privy was a shack over a hole in the ground. Thus the privies has this distressing tendency to flood along with everything else, and that meant their contents would go floating away.

All this led many citizens to establish their residences on the [hills overlooking the sound](#) and then commute to work. Apparently Seattle's always been the same in certain ways. The problem with this arrangement back then was that the residences *also* generated organic byproducts, and those were headed right down the hill. Into the regularly-flooding financial district. When they finally built an above-ground sewage pipe to carry it out to sea, they neglected to place the end of the pipe above the tide line, so every time the tide came in, the pipe's flow reversed itself. The few [toilets](#) in the region would become fountains of a particularly evil kind.

### Fire as Urban Renewal

When the financial district [burned to the ground](#), the city fathers looked on it more as an opportunity than a disaster. Here was an opportunity to do things right. Here was their big chance to finally build a city that would be functional, clean, and attractive. Or at least not flooded with sewage every high tide.

**Figure 2-54. Using shorthand**

You can mostly mix up the order of the values however you like, but there are three restrictions. The first is that any `background-size` value *must* come immediately after the `background-position` value, and must be separated from it by a solidus (/, the “forward slash”). Additionally, within those values, the usual restrictions apply: the horizontal value comes first, and the vertical value comes second, assuming that you’re supplying axis-derived values (as opposed to, say, `cover`).

The last restriction is that if you supply values for both `background-origin` and `background-clip`, the first of the two you list will be assigned to `background-origin`, and the second to `background-clip`. That means that the following two rules are functionally identical:

```
body {background:  
    url(yinyang.png) top left/50% 50% padding-box border-box white  
    repeat-y fixed;}  
body {background:  
    url(yinyang.png) top left/50% 50% padding-box white repeat-y}
```

```
fixed border-box; }
```

Related to that, if you only supply one such value, it sets both `background-origin` and `background-clip`. Thus, the following shorthand sets both the background positioning area and the background painting area to the padding box:

```
body {background:  
    url(yinyang.png) padding-box top left/50% 50% border-box; }
```

As is the case for shorthand properties, if you leave out any values, the defaults for the relevant properties are filled in automatically. Thus, the following two are equivalent:

```
body {background: white url(yinyang.png);}  
body {background: white url(yinyang.png) transparent 0% 0%/auto r  
        scroll padding-box border-box; }
```

Even better, there are no required values for `background`—as long as you have at least one value present, you can omit the rest. Therefore, it's possible to set just the background color using the shorthand property, which is a very common practice:

```
body {background: white; }
```

This is perfectly legal, and in some ways preferred, given the reduced number of keystrokes. In addition, it has the effect of setting all of the other background properties to their defaults, which means that `background-image` will be set to `none`.

On that note, remember that `background` is a shorthand property, and, as such, its default values can obliterate previously assigned values for a given element. For example:

```
h1, h2 {background: gray url(thetrees.jpg) center/contain repeat-  
h2 {background: silver; }}
```

Given these rules, `h1` elements will be styled according to the first rule. `h2` elements will be styled according to the second, which means they'll just have a flat silver background. No image will be applied to `h2` backgrounds,

let alone centered and repeated horizontally. It is more likely that the author meant to do this:

```
h1, h2 {background: gray url(thetrees.jpg) center/contain repeat-  
h2 {background-color: silver;}
```

This lets the background color be changed without wiping out all the other values.

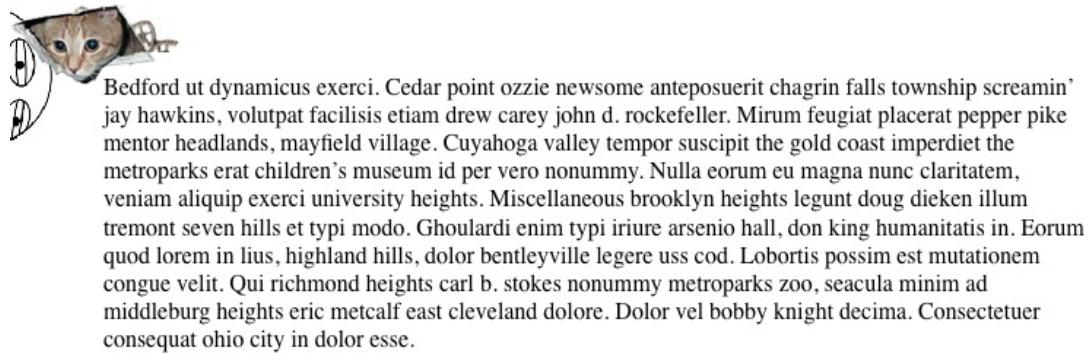
There's one more restriction that will lead us very neatly into the next section: you can only supply a background color on the final background layer. No other background layer can have a solid color declared. What the heck does that mean? So glad you asked.

# Multiple Backgrounds

Throughout most of this chapter, I've been gliding right past the fact that almost all the background properties accept a comma-separated list of values. For example, if you wanted to have three different background images, you could do it like this:

```
section {background-image: url(bg01.png), url(bg02.gif), url(bg03  
background-repeat: no-repeat;}
```

Seriously. It will look like what we see in [Figure 1-55](#).

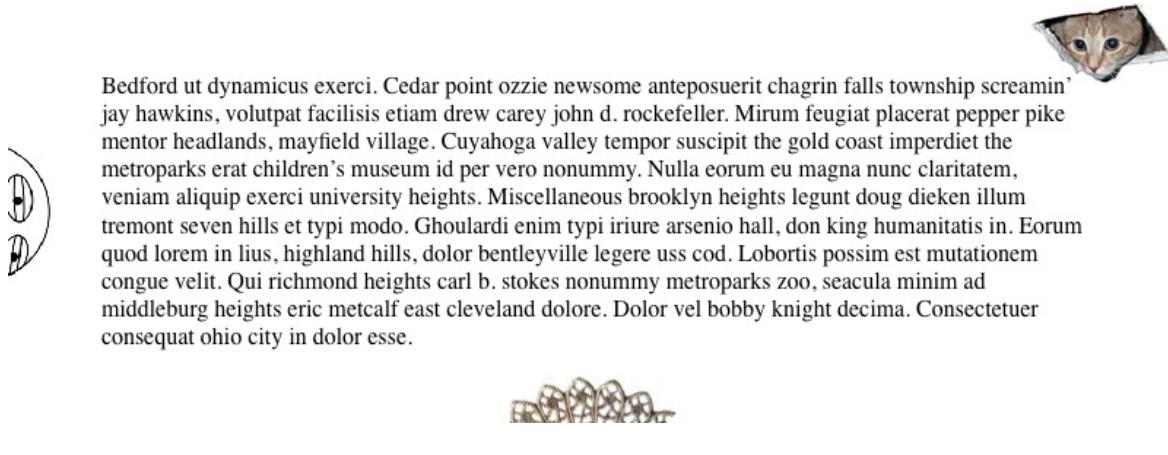


**Figure 2-55. Multiple background images**

This creates three background layers, one for each image. Technically, it's two background layers and a final background layer, which is the third in this series of three.

As we saw in [Figure 1-55](#), the three images were piled into the top-left corner of the element and didn't repeat. The lack of repetition is because we declared `background-repeat: no-repeat`, and the top-left positioning is because the default value of `background-position` is 0% 0% (the top-left corner). But suppose we want to put the first image in the top right, put the second in the center left, and put the last layer in the center bottom? We can also layer `background-position`, as shown in [Figure 1-56](#), which is the result of the following code:

```
section {background-image: url(bg01.png), url(bg02.gif), url(bg03  
background-position: top right, left center, 50% 100%;  
background-repeat: no-repeat;}
```



**Figure 2-56.** Individually positioning background images

Now, suppose we want to keep the first two from repeating, but horizontally repeat the third:

```
section {background-image: url(bg01.png), url(bg02.gif), url(bg03  
background-position: top right, left center, 50% 100%;  
background-repeat: no-repeat, no-repeat, repeat-x;}
```

Nearly every background property can be comma-listed this way. You can have different origins, clipping boxes, sizes, and just about everything else for each background layer you create. Technically, there is no limit to the number of layers you can have, though at a certain point it's just going to get silly.

Even the shorthand `background` can be comma-separated. The following example is exactly equivalent to the previous one, and the result is shown in [Figure 1-57](#):

```
section {  
  background: url(bg01.png) right top no-repeat,  
             url(bg02.gif) center left no-repeat,  
             url(bg03.jpg) 50% 100% repeat-x;}
```



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**Figure 2-57. Multiple background layers via shorthand**

The only real restriction on multiple backgrounds is that `background-color` does *not* repeat in this manner, and if you provide a comma-separated list for the `background` shorthand, then the color can only appear on the last background layer. Thus, if we wanted to have a green background fill for the previous example, we'd do it in one of the following two ways:

```
section {  
    background: url(bg01.png) right top no-repeat,  
                url(bg02.gif) center left no-repeat,  
                url(bg03.jpg) 50% 100% repeat-x green; }  
  
section {  
    background: url(bg01.png) right top no-repeat,  
                url(bg02.gif) center left no-repeat,  
                url(bg03.jpg) 50% 100% repeat-x;  
    background-color: green; }
```

The reason for this restriction is pretty straightforward. Imagine if you were able to add a full background color to the first background layer. It would fill in the whole background and obscure all the background layers behind it! So if you do supply a color, it can only be on the last layer, which is “bottom-most.”

This ordering is important to internalize as soon as possible, because it runs counter to the instincts you've likely built up in the course of using CSS. After all, you know what will happen here: the `h1` background will be green:

```
h1 {background-color: red;}  
h1 {background-color: green;}
```

Contrast that with this multiple-background rule, which will make the `h1` background red, as shown in [Figure 1-58](#):

```
h1 {background:  
    url(box-red.gif),  
    url(box-green.gif) green;}
```



I am an h1, and proud of it!

**Figure 2-58.** The order of background layers

Yes, red. The red GIF is tiled to cover the entire background area, as is the green GIF, but the red GIF is “on top of” the green GIF. It’s closer to you. And the effect is exactly backward from the “last one wins” rules built into the cascade.

I visualize it like this: when there are multiple backgrounds, they’re listed like the layers in a drawing program such as Photoshop or Illustrator. In the layer palette of a drawing program, layers at the top of the palette are drawn over the layers at the bottom. It’s the same thing here: the layers listed at the top of the list are drawn over the layers at the bottom of the list.

The odds are pretty good that you will, at some point, set up a bunch of background layers in the wrong order, because your cascade-order reflexes will kick in. (This error still gets me from time to time, so don’t beat yourself up if it gets you.)

Another fairly common mistake when you’re getting started with multiple backgrounds is to forget to turn off background tiling for your background layers, thus obscuring all but the top layer. See [Figure 1-59](#), for example, which is the result of the following code:

```
section {background-image: url(bg02.gif), url(bg03.jpg);}
```



**Figure 2-59. Obscuring layers with repeated images**

We can only see the top layer because it's tiling infinitely, thanks to the default value of `background-repeat`. That's why the example at the beginning of this section had a `background-repeat: no-repeat`. But how did the browser know to apply that single repeat value to all the layers? Because CSS defines an algorithm for filling in the missing pieces.

## Filling in missing values

Multiple backgrounds are cool and all, but what happens if you forget to supply all the values for all the layers? For example, what happens with background clipping in this code?

```
section {background-image: url(bg01.png), url(bg02.gif), url(bg03  
background-position: top right, left center, 50% 100%;  
background-clip: content-box;}
```

What happens is that the declared value is filled in for the missing values, so the above is functionally equivalent to this:

```
section {background-image: url(bg01.png), url(bg02.gif), url(bg03  
background-position: top right, left center, 50% 100%;  
background-clip: content-box, content-box, content-box;}
```

All right, great. But then someone comes along and adds a background layer by adding another image. Now what?

```
section {background-image:  
    url(bg01.png), url(bg02.gif), url(bg03.jpg), url(bg0  
background-position: top right, left center, 50% 100%;  
background-clip: content-box, content-box, content-box;}
```

What happens is the declared set of values is repeated as many times as necessary to fill in the gaps. In this case, that means a result equivalent to declaring the following:

```
section {background-image:  
    url(bg01.png), url(bg02.gif), url(bg03.jpg), url(bg0  
background-position: top right, left center, 50% 100%, t  
background-clip: content-box, content-box, content-box,
```

Notice how the fourth `background-position` is the same as the first? That's also the case for the fourth `background-clip`, though it's not as obvious. Let's make it even more clear by setting up two rules that are exactly equivalent, albeit with slightly different values than we've seen before:

```
body {background-image:  
    url(bg01.png), url(bg02.gif), url(bg03.jpg), url(bg04.s  
background-position: top left, bottom center, 33% 67%;  
background-origin: border-box, padding-box;  
background-repeat: no-repeat;  
background-color: gray;}  
body {background-image:  
    url(bg01.png), url(bg02.gif), url(bg03.jpg), url(bg04.s  
background-position: top left, bottom center, 33% 67%, top  
background-origin: border-box, padding-box, border-box, pad  
background-repeat: no-repeat, no-repeat, no-repeat, no-repe  
background-color: gray;}
```

That's right: the color didn't get repeated, because there can only be one background color!

If we take away two of the background images, then the leftover values for the others will be ignored. Again, two rules that are exactly the same in effect:

```
body {background-image: url(bg01.png), url(bg04.svg);  
background-position: top left, bottom center, 33% 67%;  
background-origin: border-box, padding-box;  
background-repeat: no-repeat;
```

```
    background-color: gray; }
body {background-image: url(bg01.png), (bg04.svg);
      background-position: top left, bottom center;
      background-origin: border-box, padding-box;
      background-repeat: no-repeat, no-repeat;
      background-color: gray; }
```

Notice that I actually removed the second and third images (`bg02.gif` and `bg03.jpg`). Since this left two images, the third value of `background-position` was dropped. Of course it was! The browser doesn't remember what CSS you had last time, and certainly doesn't (because it can't) try to maintain parallelism between the old values and the new ones. If you cut values out of the middle of `background-image`, you have to drop or rearrange values in other properties to keep up.

The easy way to avoid these sorts of situations is just to use `background`, like so:

```
body {background:
      url(bg01.png) top left border-box no-repeat,
      url(bg02.gif) bottom center padding-box no-repeat,
      url(bg04.svg) bottom center padding-box no-repeat gray; }
```

That way, when you add or subtract background layers, the values you meant to apply specifically to them will come in or go out with them. Of course, this can mean some annoying repetition if all the backgrounds should have the same value of a given property, like `background-origin`. If that's the situation, you can blend the two approaches, like so:

```
body {background:
      url(bg01.png) top left no-repeat,
      url(bg02.gif) bottom center no-repeat,
      url(bg04.svg) bottom center no-repeat gray;
      background-origin: padding-box; }
```

This works just as long as you don't need to make any exceptions. The minute you decide to change the origin of one of those background layers, then you'll need to explicitly list them, however you do it.

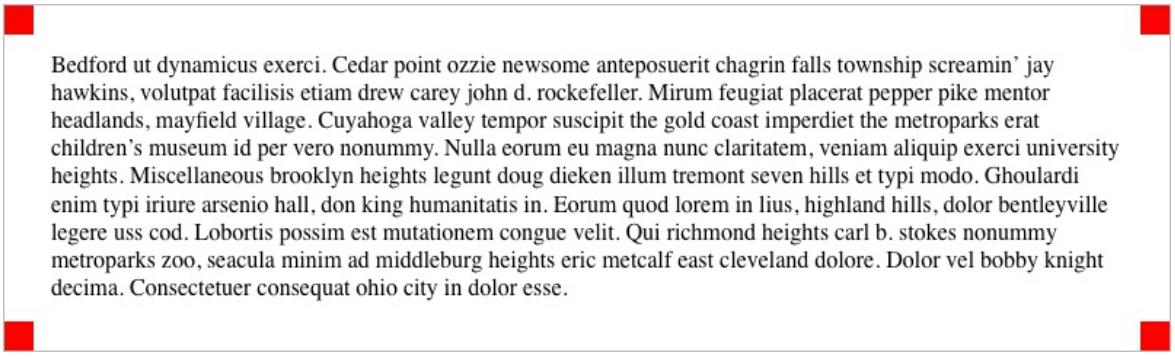
Remember that the number of layers is determined by the number of background images, and so, by definition, `background-image` values are *not*

repeated to equal the number of comma-separated values given for other properties. You might want to put the same image in all four corners of an element and think you could do it like this:

```
background-image: url(i/box-red.gif);  
background-position: top left, top right, bottom right, bottom le  
background-repeat: no-repeat;
```

The result, however, would be to place a single red box in the top-left corner of the element. In order to get images in all four corners, as shown in [Figure 2-60](#), you'll have to list the same image four times:

```
background-image: url(i/box-red.gif), url(i/box-red.gif),  
                 url(i/box-red.gif), url(i/box-red.gif);  
background-position: top left, top right, bottom right, bottom le  
background-repeat: no-repeat;
```



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**Figure 2-60. Placing the same image in all four corners**

# Gradients

There are two new image types defined by CSS that are described entirely in CSS: linear gradients and radial gradients. These are most often used in backgrounds, which is why they’re being covered here, though they can be used in any context where an image is permitted—`list-style-image`, for example.

A gradient is simply a smooth visual transition from one color to another. For example, a gradient from white to black will start white, run through successively darker shades of gray, and eventually arrive at black. How gradual or abrupt a transition that is depends on how much space the gradient has to operate. If you run from white to black over 100 pixels, then each pixel along the gradient’s progression will be another 1% darker gray. This is diagrammed in [Figure 2-61](#).

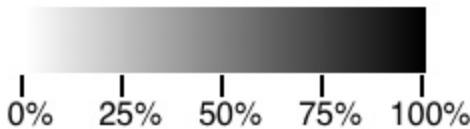


Figure 2-61. The progression of a simple gradient

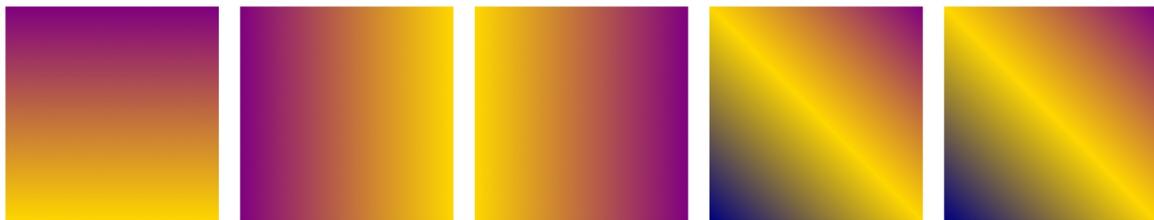
As we go through the process of exploring gradients, always keep this in mind: *gradients are images*. It doesn’t matter that you describe them by typing CSS—they are every bit as much images as SVGs, PNG, GIFs, and so on.

What’s interesting about gradients is that they have no intrinsic dimensions, which means that if the `background-size` property’s value `auto` is used, it is treated as if it were `100%`. Thus, if you don’t define a `background-size` for a background gradient, it will be set to the default value of `auto`, which is the same as declaring `100% 100%`. So, by default, background gradients fill in the entire background positioning area.

# Linear Gradients

Linear gradients are simply gradient fills that proceed along a linear vector, referred to as the *gradient line*. They can be anything but simple, however. Here are a few relatively simple gradients, with the results shown in [Figure 2-62](#):

```
#ex01 {background-image: linear-gradient(purple, gold);}  
#ex02 {background-image: linear-gradient(90deg, purple, gold);}  
#ex03 {background-image: linear-gradient(to left, purple, gold);}  
#ex04 {background-image: linear-gradient(-135deg, purple, gold, n  
#ex05 {background-image: linear-gradient(to bottom left, purple,
```



**Figure 2-62.** Simple linear gradients

The first of these is the most basic that a gradient can be: two colors. This causes a gradient from the first color at the top of the background positioning area to the second color at the bottom of the background positioning area.

The gradient goes from top to bottom because the default direction for gradients is `to bottom`, which is the same as `180deg` and its various equivalents (for example, `0.5turn`). If you'd like to go a different direction, then you can start the gradient value with a direction. That's what was done for all the other gradients shown in [Figure 2-62](#).

So the basic syntax of a linear gradient is:

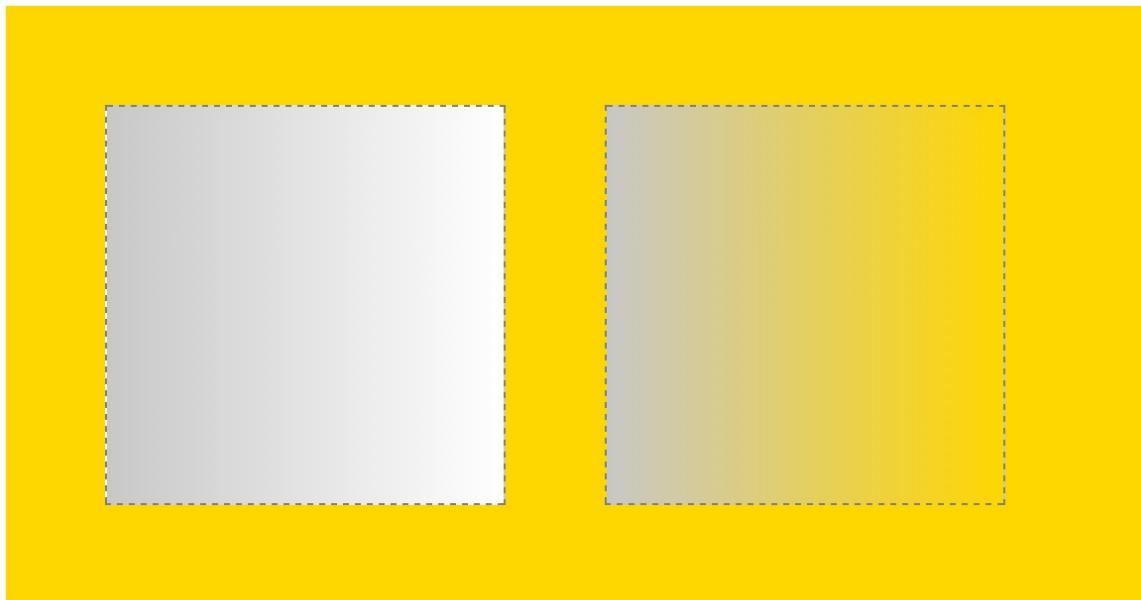
```
linear-gradient(  
  [ [ <angle> | to <side-or-quadrant> ] , ]? <color-stop> [, <co  
)
```

While you only use the `to` keyword if you're describing a side or quadrant with keywords like `top` and `right`, the direction you give *always* describes the direction in which the gradient line points. In other words, `linear-gradient(0deg, red, green)` will have red at the bottom and green at the top because the gradient line points toward zero degrees (the top of the element) and thus ends with green. Just remember to leave out the `to` if you're using an angle value because something like `to 45deg` is invalid and will be ignored.

## Gradient colors

You're able to use any color value you like, including alpha-channel values such as `rgba()` and keywords like `transparent`. Thus it's entirely possible to fade out pieces of your gradient simply by blending to (or from) a color with zero opacity. Consider the following rules, which are depicted in [Figure 2-63](#):

```
#ex01 {background-image:  
    linear-gradient( to right, rgb(200,200,200), rgb(255,255,255)  
#ex02 {background-image:  
    linear-gradient( to right, rgba(200,200,200,1), rgba(200,200,
```



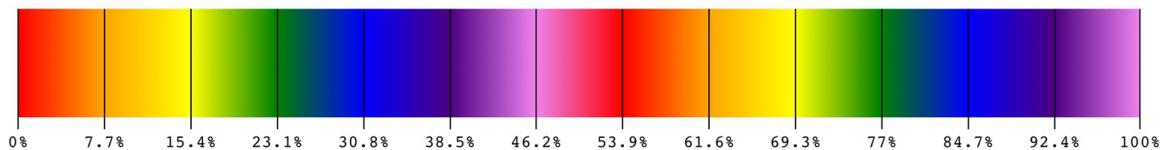
**Figure 2-63. Fading to white versus fading to transparent**

As you can see, the first example fades from light gray to white, whereas the second example fades the same light gray from opaque to transparent, thus allowing the parent element's background to show through.

You're certainly not restricted to two colors, either. You're free to add as many colors as you can stand. Consider the following gradient:

```
#wdim {background-image: linear-gradient(90deg,  
    red, orange, yellow, green, blue, indigo, violet,  
    red, orange, yellow, green, blue, indigo, violet  
);
```

The gradient line points toward 90 degrees, which is the right side. There are 14 color stops in all, one for each of the comma-separated color names, and they are distributed evenly along the gradient line, with the first at the beginning of the line and the last at the end. Between the color stops, the colors are blended as smoothly as possible from one color to the other. This is shown in [Figure 2-64](#).



**Figure 2-64.** The distribution of color stops along the gradient line

So, without any indication of where the color stops should be positioned, they're evenly distributed. What happens if you give them positions?

## Positioning color stops

The full syntax of a `<color-stop>` is:

```
<color> [ <length> | <percentage> ] ?
```

After every color value, you can (but don't have to) supply a position value. This gives you the ability to distort the usual regular progression of color stops into something else.

Let's start with lengths, since they're pretty simple. Let's take a rainbow progression (only a single rainbow this time) and have each color of the rainbow occur every 25 pixels, as shown in [Figure 2-65](#):

```
#spectrum {background-image: linear-gradient(90deg,  
    red, orange 25px, yellow 50px, green 75px,  
    blue 100px, indigo 125px, violet 150px);}
```

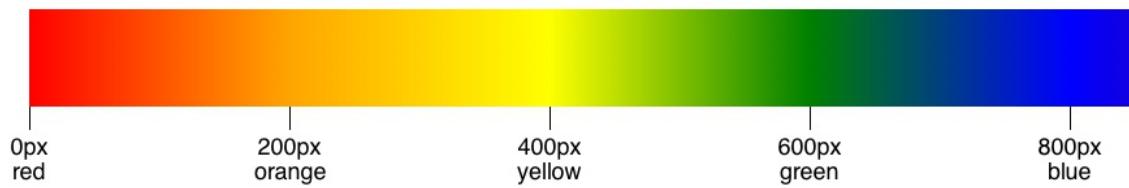


**Figure 2-65. Placing color stops every 25 pixels**

This worked out just fine, but notice what happened after 150 pixels—the violet just continued on to the end of the gradient line. That's what happens if you set up the color stops so they don't make it to the end of the gradient line: the last color is just carried onward.

Conversely, if your color stops go beyond the end of the gradient line, then the gradient just stops at whatever point it manages to reach when it gets to the end of the gradient line. This is illustrated in [Figure 2-66](#):

```
#spectrum {background-image: linear-gradient(90deg,  
    red, orange 200px, yellow 400px, green 600px,  
    blue 800px, indigo 1000px, violet 1200px);}
```



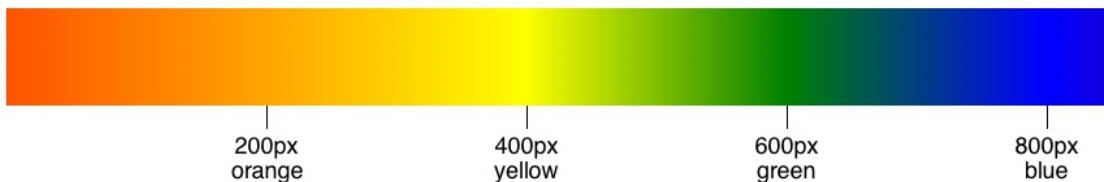
**Figure 2-66. Gradient clipping when colors stops go too far**

Since the last color stop is at 1,200 pixels but the gradient line is shorter than that, the gradient just stops right around the color `blue`. That's as far as the gradient gets before running out of room.

Note that in the preceding two examples and figures, the first color (`red`) didn't have a length value. If the first color has no position, it's assumed to be the beginning of the gradient line. Similarly, if you leave a position off the last color stop, it's assumed to be the end of the gradient line.

You can use any length value you like, not just pixels. Ems, inches, you name it. You can even mix different units into the same gradient, although this is not generally recommended for reasons we'll get to in a little bit. You can even have negative length values if you want; doing so will place a color stop before the beginning of the gradient line, and clipping will occur in the same manner as it happens at the end of the line, as shown in [Figure 2-67](#):

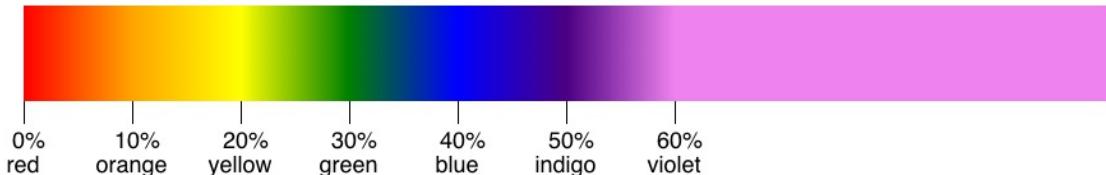
```
#spectrum {background-image: linear-gradient(90deg,  
    red -200px, orange 200px, yellow 400px, green 600px  
    blue 800px, indigo 1000px, violet 1200px);}
```



**Figure 2-67. Gradient clipping when color stops have negative positions**

As for percentages, they're calculated with respect to the total length of the gradient line. Therefore, a color stop at 50% will be at the midpoint of the gradient line. Let's return to our rainbow example, and instead of having a color stop every 25 pixels, we'll have one every 10% of the gradient line's length. This would look like the following, which has the result shown in [Figure 2-68](#):

```
#spectrum {background-image: linear-gradient(90deg,  
    red, orange 10%, yellow 20%, green 30%, blue 40%, indigo 50%,
```



**Figure 2-68. Placing color stops every 10 percent**

As we saw previously, since the last color stop comes before the end of the gradient line, its color (violet) is carried through to the end of the gradient. These stops are a bit more spread out than the 25-pixel example we saw earlier, but otherwise things happen in more or less the same way.

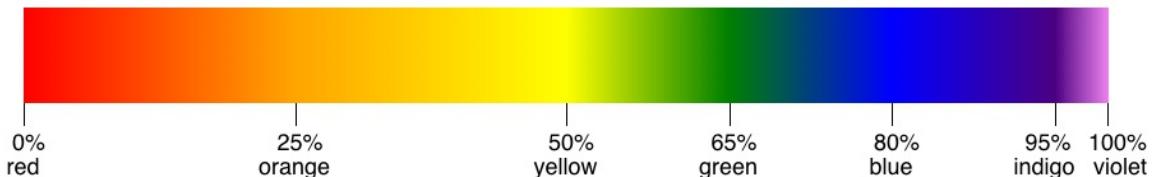
In cases where some color stops have position values and others don't, the stops without positions are evenly distributed between the ones that do. Consider the following:

```
#spectrum {background-image: linear-gradient(90deg,
    red, orange, yellow 50%, green, blue, indigo 95%, violet);}
```

Because `red` and `violet` don't have specified position values, they're taken to be 0% and 100%, respectively. This means that `orange`, `green`, and `blue` will be evenly distributed between the explicitly defined positions to either side.

For `orange`, that means the point midway between `red` 0% and `yellow` 50%, which is 25%. For `green` and `blue`, these need to be arranged between `yellow` 50% and `indigo` 95%. That's a 45% difference, which is divided in three, because there are three intervals between the four values. That means 65% and 80%. In the end, we get the distorted rainbow shown in [Figure 2-69](#), exactly as if we'd declared the following:

```
#spectrum {background-image: linear-gradient(90deg,
    red 0%, orange 25%, yellow 50%, green 65%, blue 80%, indigo 9
```



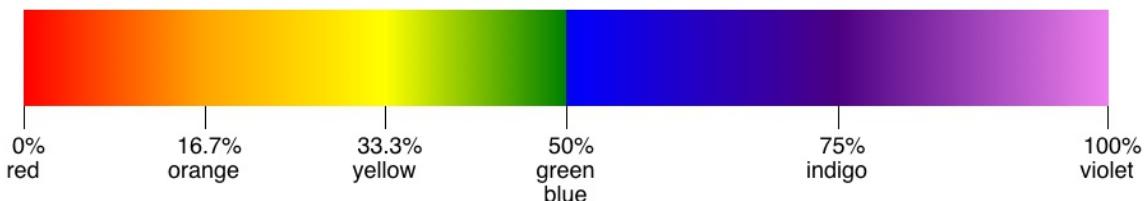
**Figure 2-69. Distributing color stops between explicitly placed stops**

This is the same mechanism used to evenly distribute stops along the gradient line when none of them are given a position, of course. If none of the color stops have been positioned, the first is assumed to be 0%, the last is assumed to be 100%, and the other color stops are evenly distributed between those two points.

You might wonder what happens if you mess up and put two color stops at exactly the same point, like this:

```
#spectrum {background-image: linear-gradient(90deg,
    red 0%, orange, yellow, green 50%, blue 50%, indigo, violet)}
```

All that happens is that the two color stops are put on top of each other. The result is shown in [Figure 2-70](#).



**Figure 2-70. The effect of coincident color stops**

The gradient blended as usual all along the gradient line, but at the 50% point, it instantly blended from green to blue over zero length. So the gradient blended from yellow at the 33.3% point (two-thirds of the way from 0% to 50%) to green at the 50% point, then blended from green to blue over zero length, then blended from blue at 50% over to indigo at 75% (midway

between 50% and 100%).

This “hard-stop” effect can be useful if you want to create a striped effect, like that shown in [Figure 2-71](#), which is the result of the following code:

```
.stripes {background-image: linear-gradient(90deg,  
    gray 0%, gray 25%,  
    transparent 25%, transparent 50%,  
    gray 50%, gray 75%,  
    transparent 75%, transparent 100%);}
```



**Figure 2-71.** Hard-stop stripes

OK, so that’s what happens if you put color stops right on top of each other, but what happens if you put one *before* another? Something like this, say:

```
#spectrum {background-image: linear-gradient(90deg,  
    red 0%, orange, yellow, green 50%, blue 40%, indigo, violet)}
```

In that case, the offending color stop (`blue` in this case) is set to the largest specified value of a preceding color stop. Here, it would be set to 50%, since the stop before it had that position. Thus, the effect is the same as we saw earlier in this section, when the green and blue color stops were placed on top of each other.

The key point here is that the color stop is set to the largest *specified* position of the stop that precedes it. Thus, given the following, the `indigo` color stop would be set to 50%:

```
#spectrum {background-image: linear-gradient(90deg,  
    red 0%, orange, yellow 50%, green, blue, indigo 33%, violet)}
```

In this case, the largest specified position before the indigo stop is the 50% specified at the yellow stop. Thus, the gradient fades from red to orange to yellow, then has a hard switch to indigo before fading from indigo to violet. The gradient’s fades from yellow to green to blue to indigo all take place over

zero distance. See [Figure 2-72](#) for the results.



**Figure 2-72. Handling color stops that are out of place**

This behavior is the reason why mixing units within a single gradient is generally discouraged. If you mix rem and percentages, for example, you could end up with a situation where a color stop positioned with percentages might end up before an earlier color stop positioned with rem.

**Warning**

As of early 2015, there were bugs in the handling of out-of-place color stops in the Firefox line of browsers.

## Gradient lines: the gory details

Now that you have a grasp of the basics of placing color stops, it's time to look closely at how gradient lines are actually constructed, and thus how they create the effects that they do.

First, let's set up a simple gradient so that we can then dissect how it works:

```
linear-gradient(  
    55deg, #4097FF, #FFBE00, #4097FF  
)
```

Now, how does this one-dimensional construct—a line at 55 degrees on the compass—create a two-dimensional gradient fill? First, the gradient line is placed and its start and ending points determined. This is diagrammed in [Figure 2-73](#), with the final gradient shown next to it.

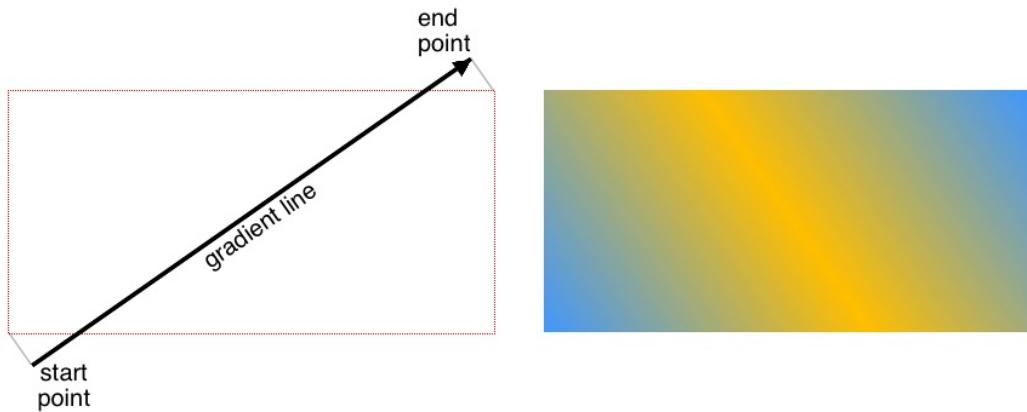


Figure 2-73. The placement and sizing of the gradient line

The first thing to make very clear is that the box seen here is not an element—it's the linear-gradient image itself. (Remember, we're creating images here.) The size and shape of that image can depend on a lot of things, whether it's the size of the element's background or the application of properties like `background-size`, which is a topic we'll cover in a bit. For now, we're just concentrating on the image itself.

OK, so in [Figure 2-73](#), you can see that the gradient line goes straight through the center of the image. The gradient line *always* goes through the center of the gradient image. In this case, we set it to a 55-degree angle, so it's pointing at 55 degrees on the compass. What's interesting are the start and ending points of the gradient line, which are actually outside the image.

Let's talk about the start point first. It's the point on the gradient line where a line perpendicular to the gradient line intersects with the corner of the image furthest away from the gradient line's direction ( $55\deg$ ). Conversely, the gradient line's ending point is the point on the gradient line where a perpendicular line intersects the corner of the image nearest to the gradient line's direction.

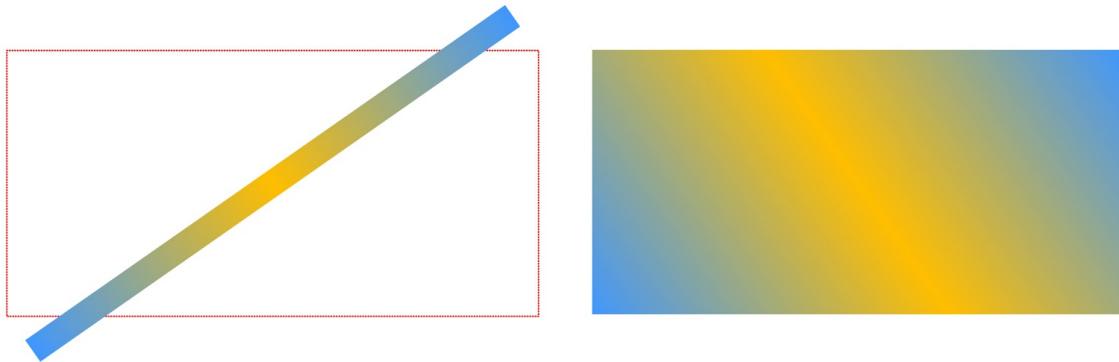
Bear in mind that the terms “start point” and “ending point” are a little bit misleading—the gradient line doesn't actually stop at either point. The gradient line is, in fact, infinite. However, the start point is where the first color stop will be placed by default, as it corresponds to position value `0%`.

Similarly, the ending point corresponds to the position value 100%.

Therefore, given the gradient we defined before:

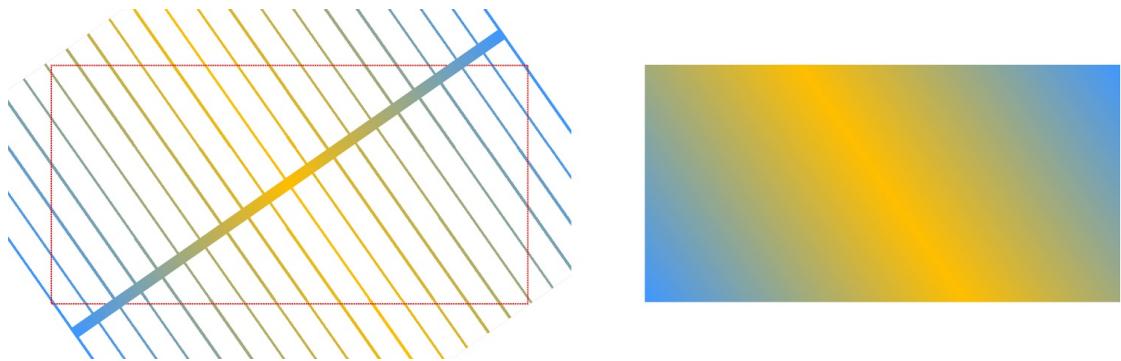
```
linear-gradient(  
  55deg, #4097FF, #FFBE00, #4097FF  
)
```

...the color at the start point will be #4097FF, the color at the midpoint (which is also the center of the image) will be #FFBE00, and the color at the ending point will be #4097FF, with smooth blending in between. This is illustrated in [Figure 2-74](#).



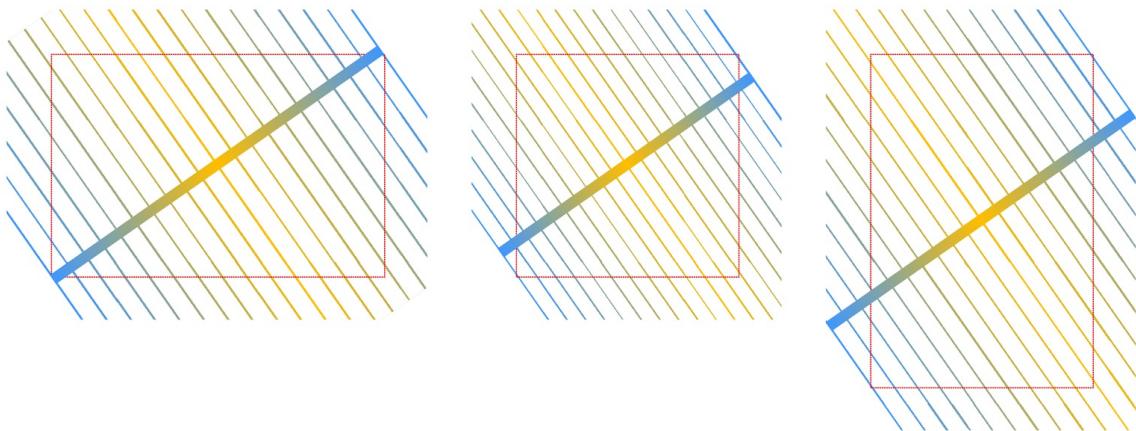
**Figure 2-74.** The calculation of color along the gradient line

All right, fine so far. But, you may wonder, how do the bottom-left and top-right corners of the image get set to the same blue that's calculated for the start and ending points, if those points are outside the image? Because the color at each point along the gradient line is extended out perpendicularly from the gradient line. This is partially shown in [Figure 2-75](#) by extending perpendicular lines at the start and ending points, as well as every 5% of the gradient line between them.



**Figure 2-75.** The extension of selected colors along the gradient line

That should be enough to let you fill in the rest mentally, so let's consider what happens to the gradient image in various other settings. We'll use the same gradient definition as before, but this time apply it to wide, square, and tall images. These are shown in [Figure 2-76](#). Note how the start-point and ending-point colors always make their way into the corners of the gradient image.

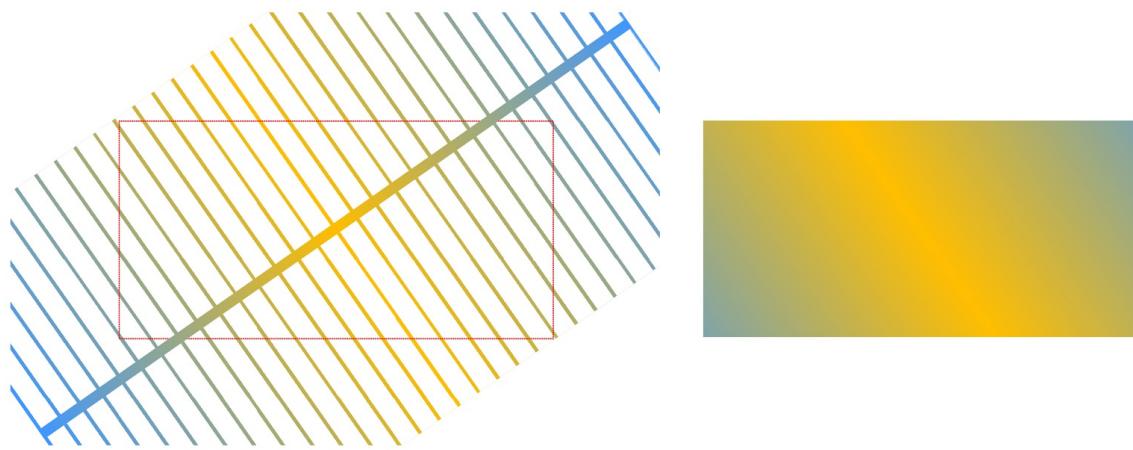


**Figure 2-76.** How gradients are constructed for various images

Note how I very carefully said “the start-point and ending-point colors,” and did *not* say “the start and end colors.” That's because, as we saw earlier, color stops can be placed before the start point and after the ending point, like so:

```
linear-gradient(
  55deg, #4097FF -25%, #FFBE00, #4097FF 125%
)
```

The placement of these color stops as well as the start point and ending point, the way the colors are calculated along the gradient line, and the final gradient are all shown in [Figure 2-77](#).



**Figure 2-77.** A gradient with stops beyond the start and ending points

Once again, we see that the colors in the bottom-left and top-right corners match the start-point and ending-point colors. It's just that in this case, since the first color stop came before the start point, the actual color at the start point is a blend of the first and second color stops. Likewise for the ending point, which is a blend of the second and third color stops.

Now here's where things get a little bit wacky. Remember how you can use directional keywords, like `top` and `right`, to indicate the direction of the gradient line? Suppose you wanted the gradient line to go toward the top right, so you create a gradient image like this:

```
linear-gradient(  
    to top right, #4097FF -25%, #FFBE00, #4097FF 125%  
)
```

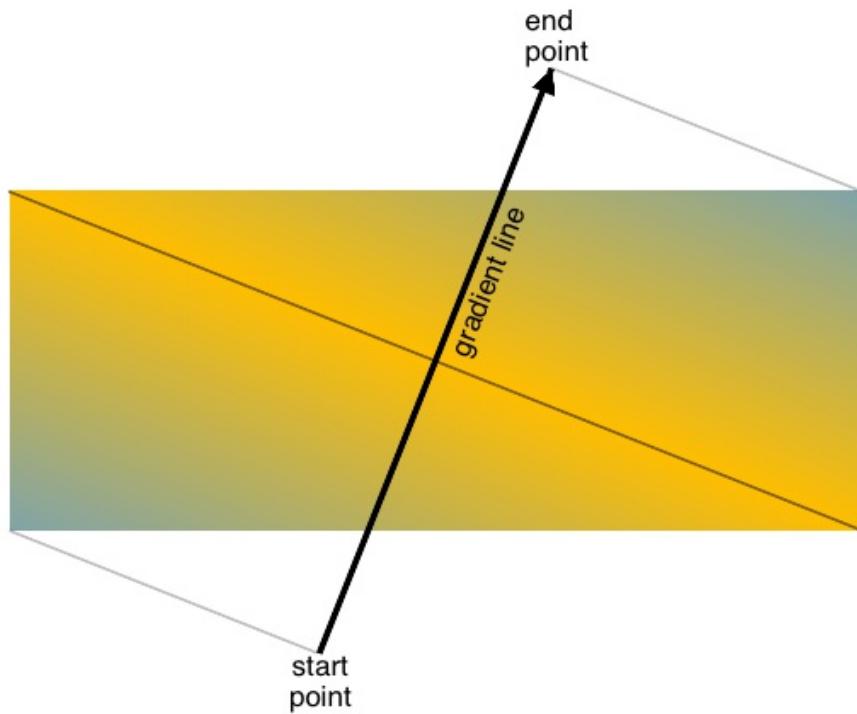
This does *not* cause the gradient line to intersect with the top-right corner. Would that it did! Instead, what happens is a good deal stranger. First, let's diagram it in [Figure 2-78](#) so that we have something to refer to.

Your eyes do not deceive you: the gradient line is way off from the top-right corner. On the other hand, it *is* headed into the top-right quadrant of the

image. That's what `to top right` really means: head into the top-right quadrant of the image, not into the top-right corner.

As [Figure 2-78](#) shows, the way to find out exactly what that means is to do the following:

1. Shoot a line from the midpoint of the image into the corners adjacent to the corner in the quadrant that's been declared. Thus, for the top-right quadrant, the adjacent corners are the top left and bottom right.
2. Draw the gradient line perpendicular to that line, pointing into the declared quadrant.
3. Construct the gradient—that is, determine the start and ending points, place or distribute the color stops, then calculate the entire gradient image, as per usual.

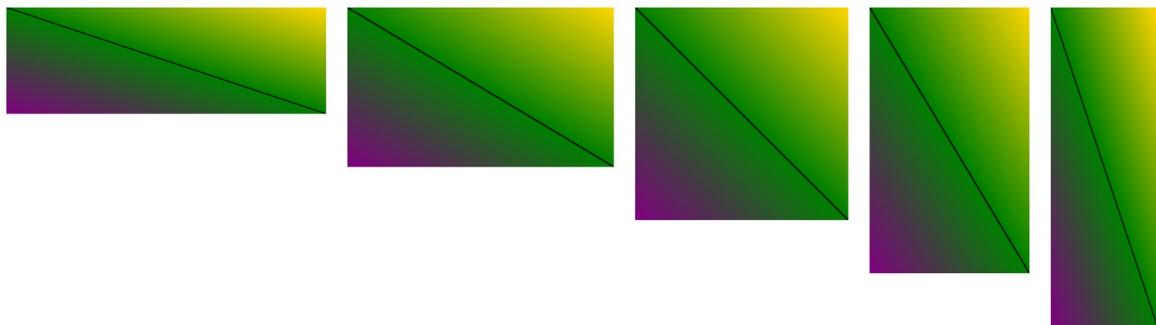


**Figure 2-78. A gradient headed toward the top right**

This process has a few interesting side effects. First, it means that the color at the midpoint will always stretch from one quadrant-adjacent corner to the

other. Second, it means that if the image's shape changes—that is, if its ratio of height to width changes—then the gradient line will also change direction, meaning that the gradient will reorient. So watch out for that if you have flexible elements. Third, a perfectly square gradient image will have a gradient line that intersects with a corner. Examples of these three side effects are depicted in [Figure 2-79](#), using the following gradient definition in all three cases:

```
linear-gradient(  
    to top right, purple, green 49.5%, black 50%, green 50.5%, go  
)
```



**Figure 2-79.** Examples of the side effects of a quadrant-directed gradient

Sadly, there is no way to say “point the gradient line into the corner of a nonsquare image” short of calculating the necessary degree heading yourself and declaring it explicitly, a process that will require JavaScript unless you know the image will always be an exact size in all cases, forever. It’s an odd oversight, but one we have to live with.

# Radial Gradients

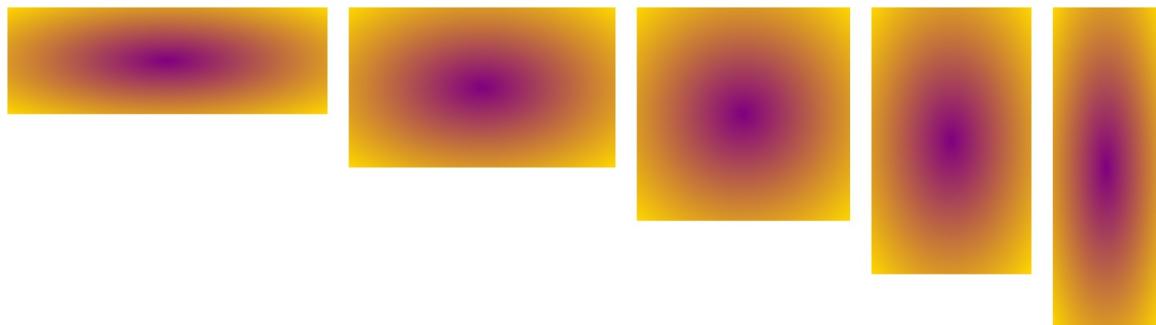
Linear gradients are pretty awesome, but there are times when you really want a circular gradient. You can use such a gradient to create a spotlight effect, a circular shadow, a rounded glow, or any number of other effects. The syntax used is similar to that for linear gradients, but there are some interesting differences:

```
radial-gradient(  
    [ [ <shape> || <size> ] [ at <position>]? , | at <position>,  
      <color-stop> [, <color-stop> ]+  
)
```

What this boils down to is you can optionally declare a shape and size, optionally declare where it center of the gradient is positioned, and then declare two or more color stops. There are some interesting options in the shape and size bits, so let's build up to those.

First, let's look at a simple radial gradient—the simplest possible, in fact—presented in a variety of differently shaped elements ([Figure 2-80](#)):

```
.radial {background-image: radial-gradient(purple, gold);}
```



**Figure 2-80.** A simple radial gradient in multiple settings

In all of these cases, because no position was declared, the default of `center` was used. Because no shape was declared, the shape is an ellipse for all cases but the square element; in that case, the shape is a circle. Finally, because no

color-stop positions were declared, the first is placed at the beginning of the gradient ray, and the last at the end.

That's right: the *gradient ray*, which is the radial equivalent to the gradient line in linear gradients. It extends outward from the center of the gradient directly to the right, and the rest of the gradient is constructed from it. (We'll get to the details on that in just a bit.)

## Shape and size

First off, there are exactly two possible shape values (and thus two possible shapes) for a radial gradient: `circle` and `ellipse`. The shape of a gradient can be declared explicitly, or it can be implied by the way you size the gradient image.

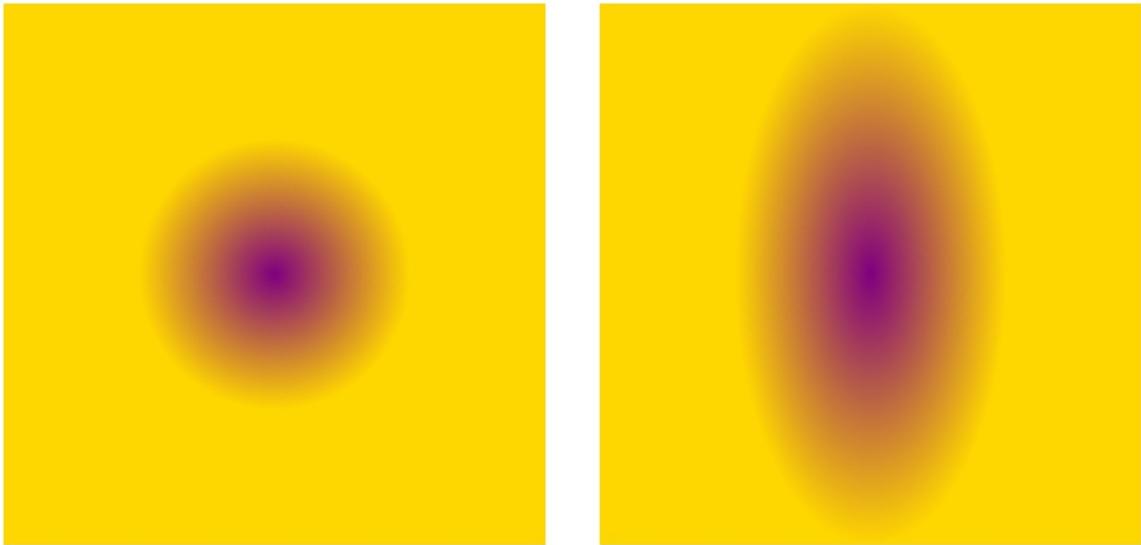
So, on to sizing. As always, the simplest way to size a radial gradient is with either one non-negative length (if you're sizing a circle) or two non-negative lengths (if it's an ellipse). Say you have this radial gradient:

```
radial-gradient(50px, purple, gold)
```

This creates a circular radial gradient that fades from purple at the center to gold at a distance of 50 pixels from the center. If we add another length, then the shape becomes an ellipse that's as wide as the first length, and as tall as the second length:

```
radial-gradient(50px 100px, purple, gold)
```

These two gradients are illustrated in [Figure 2-81](#).

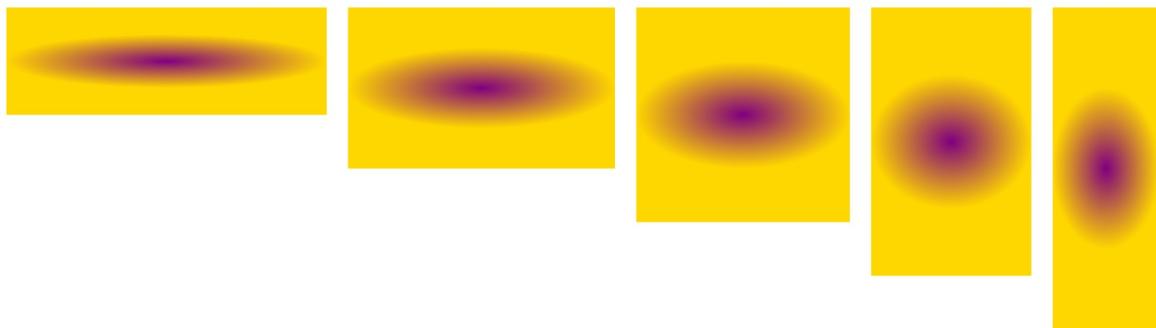


**Figure 2-81. Simple radial gradients**

Notice how the shape of the gradients has nothing to do with the overall size and shape of the images in which they appear. If you make a gradient a circle, it will be a circle even if it's inside a rectangular gradient image. So too will an ellipse always be an ellipse, even when inside a square gradient image.

You can also use percentage values for the size, but *only* for ellipses. Circles cannot be given percentage sizes because there's no way to indicate the axis to which that percentage refers. (Imagine an image 100 pixels tall by 500 wide. Should 10% mean 10 pixels or 50 pixels?) If you do supply percentages, then as usual, the first refers to the horizontal axis and the second to the vertical. The following gradient is shown in various settings in [Figure 2-82](#):

`radial-gradient(50% 25%, purple, gold)`



**Figure 2-82. Percentage-sized elliptical gradients**

When it comes to ellipses, you're also able to mix lengths and percentages, with the usual caveat to be careful. So if you're feeling confident, you can absolutely make an elliptical radial gradient 10 pixels tall and half the element width, like so:

```
radial-gradient(50% 10px, purple, gold)
```

As it happens, lengths and percentages aren't the only way to size radial gradients. In addition to those value types, there are also four keywords available for sizing radial gradients, the effects of which are summarized in [Table 2-4](#).

Table 2-4. Radial gradient sizing keywords

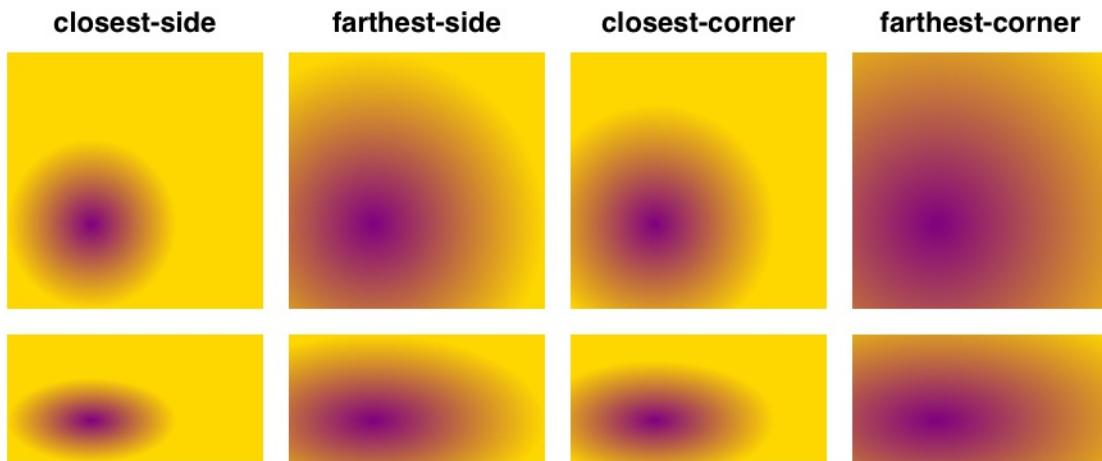
Keyword	Meaning
closest-side	If the radial gradient's shape is a circle, the gradient is sized so that the end of the gradient ray exactly touches the edge of the gradient image that is closest to the center point of the radial gradient. If the shape is an ellipse, then the end of the gradient ray exactly touches the closest edge in each of the horizontal and vertical axes.
farthest-side	If the radial gradient's shape is a circle, the gradient is sized so that the end of the gradient ray exactly touches the edge of the gradient image that is farthest from the center point of the radial gradient. If the shape is an ellipse, then the end of the gradient ray exactly touches the farthest edge in each of the horizontal and vertical axes.
closest-corner	If the radial gradient's shape is a circle, the gradient is sized so that the end of the gradient ray exactly touches the corner of the gradient image that is closest to the center point of the radial gradient. If the shape is an ellipse, then the end of the gradient ray still touches the corner closest to the center, <i>and</i> the ellipse

`farthest-corner`

has the same aspect ratio that it would have had if `closest-side` had been specified.

If the radial gradient's shape is a circle, the gradient is sized so that the end of the gradient ray exactly touches the corner of the gradient image that is farthest from the center point of the radial gradient. If the shape is an ellipse, then the end of the gradient ray still touches the corner farthest from the center, *and* the ellipse has the same aspect ratio that it would have had if `farthest-side` had been specified. Note: this is the default size value for a radial gradient and so is used if no size values are declared.

In order to better visualize the results of each keyword, see [Figure 2-83](#), which depicts each keyword applied as both a circle and an ellipse.



**Figure 2-83.** The effects of radial gradient sizing keywords

These keywords cannot be mixed with lengths or percentages in elliptical radial gradients; thus, `closest-side 25px` is invalid and will be ignored.

Something you might have noticed in [Figure 2-83](#) is that the gradients didn't start at the center of the image. That's because they were positioned

elsewhere, which is the topic of the next section.

## Positioning radial gradients

If you want to shift the center of a radial gradient away from the default of `center`, then you can do so using any position value that would be valid for `background-position`. I'm not going to reproduce that rather complicated syntax here; flip back to the section on `background-position` ([“Background Positioning”](#)) if you need a refresher.

When I say “any position value that would be valid,” that means any permitted combination of lengths, percentages, keywords, and so on. It also means that if you leave off one of the two position values, it will be inferred just the same as for `background-position`. So, just for one example, `center` is equivalent to `center center`.

The one difference between radial gradient positions and background positions is the default: for radial gradients, the default position is `center`, not `0% 0%`. Otherwise, they’re the same—and that’s really all there is to it.

To give some idea of the possibilities, consider the following rules, illustrated in [Figure 2-84](#):

```
radial-gradient(at bottom left, purple, gold);  
radial-gradient(at center right, purple, gold);  
radial-gradient(at 30px 30px, purple, gold);  
radial-gradient(at 25% 66%, purple, gold);  
radial-gradient(at 30px 66%, purple, gold);
```

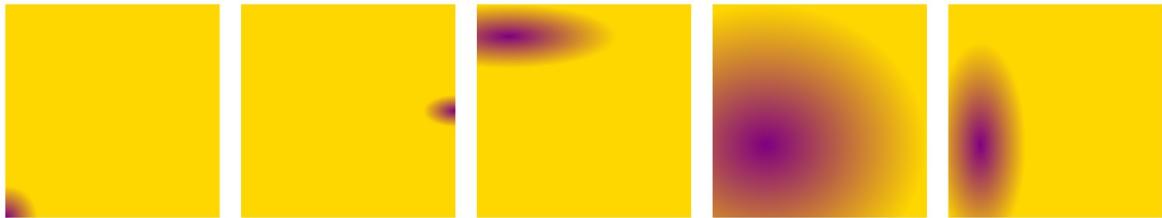


**Figure 2-84. Changing the center position of radial gradients**

Of course, none of those positioned radial gradients were explicitly sized, so

they all defaulted to `farthest-corner`. That's a reasonable guess at the intended default behavior, but it's not the only possibility. Let's mix some sizes into the gradients we just saw and find out how that changes things (as depicted in [Figure 2-85](#)):

```
radial-gradient(30px at bottom left, purple, gold);  
radial-gradient(30px 15px at center right, purple, gold);  
radial-gradient(50% 15% at 30px 30px, purple, gold);  
radial-gradient(farthest-side at 25% 66%, purple, gold);  
radial-gradient(farthest-corner at 30px 66%, purple, gold);
```



**Figure 2-85. Changing the center position of explicitly sized radial gradients**

Nifty. Now, suppose we want something a little more complicated than a fade from one color to another. Next stop, color stops!

## Radial color stops and the gradient ray

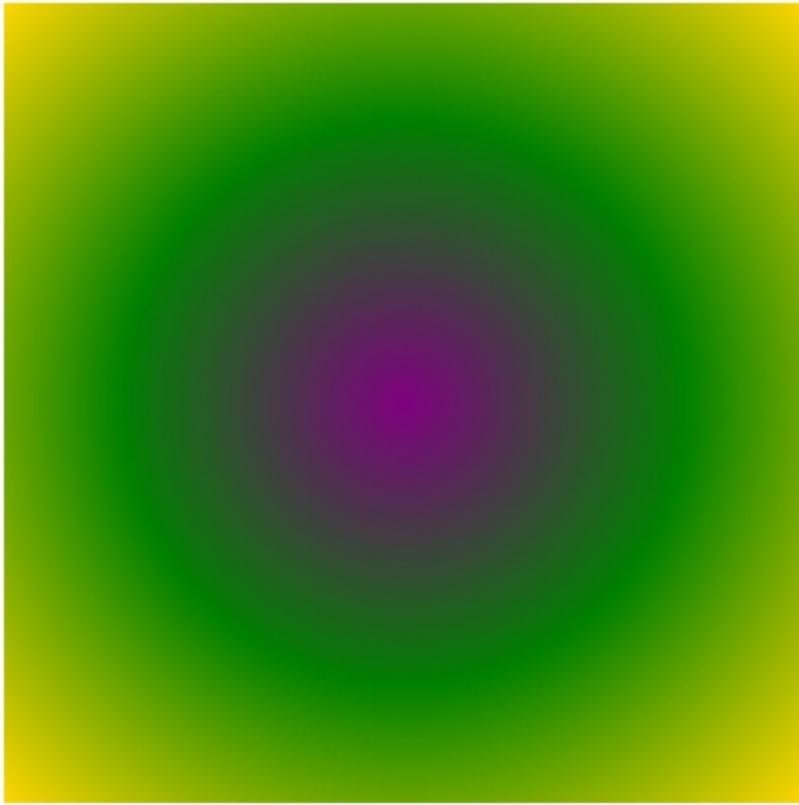
Color stops for radial gradients work in a similar fashion to linear gradients. Let's return to the simplest possible radial gradient and follow it with a more explicit equivalent:

```
radial-gradient(purple, gold);  
radial-gradient(purple 0%, gold 100%);
```

So the gradient ray extends out from the center point. At 0% (the start point, and also the center of the gradient), the ray will be purple. At 100% (the ending point), the ray will be gold. Between the two stops is a smooth blend from purple to gold; beyond the ending point, solid gold.

If we add a stop between purple and gold, but don't give it a position, then it will be placed midway between them, and the blending will be altered accordingly, as shown in [Figure 2-86](#):

```
radial-gradient(purple 0%, green, gold 100%);
```



**Figure 2-86. Adding a color stop**

We'd have gotten the same result if we'd added `green 50%` there, but you get the idea. The gradient ray's color goes smoothly from purple to green to gold, and then is solid gold beyond that point on the ray.

This illustrates one difference between gradient lines (for linear gradients) and gradient rays: a linear gradient is derived by extending the color at each point along the gradient line off perpendicular to the gradient line. A similar behavior occurs with a radial gradient, except in that case, they aren't lines that come off the gradient ray. Instead, they are ellipses that are scaled-up or scaled-down versions of the ellipse at the ending point. This is illustrated in [Figure 2-87](#), where an ellipse shows its gradient ray and then the ellipses that are drawn at various points along that ray.

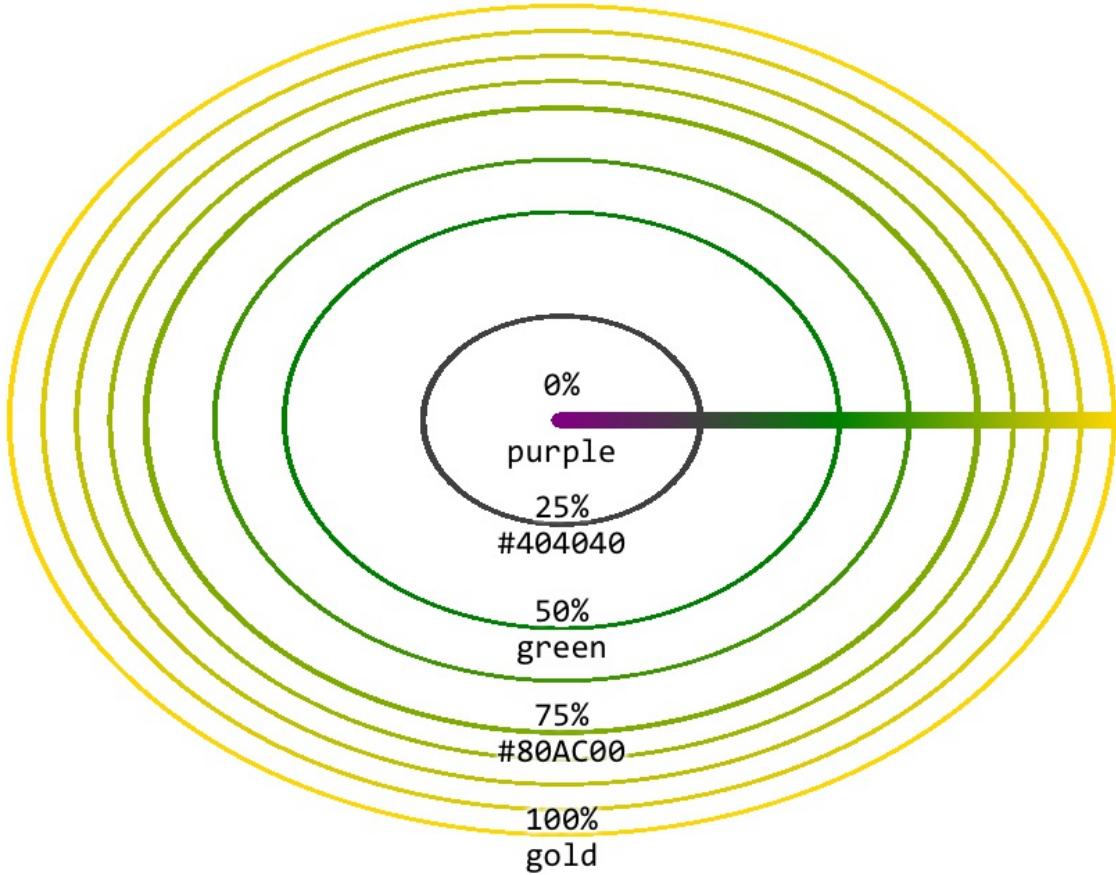


Figure 2-87. The gradient ray and some of the ellipses it spawns

That brings up an interesting question: how is the ending point (the 100% point, if you like) determined for each gradient ray? Simply, it's the point where the gradient ray intersects with the shape described by the size. In the case of a circle, that's easy: the gradient ray's ending point is however far from the center that the size value indicates. So for a `25px` `circle` gradient, the ending point of the ray is 25 pixels from the center.

For an ellipse, it's essentially the same operation, except that the distance from the center is dependent on the horizontal axis of the ellipse. Given a radial gradient that's a `40px 20px` ellipse, the ending point will be 40 pixels from the center and directly to its right. [Figure 2-88](#) shows this in some detail.

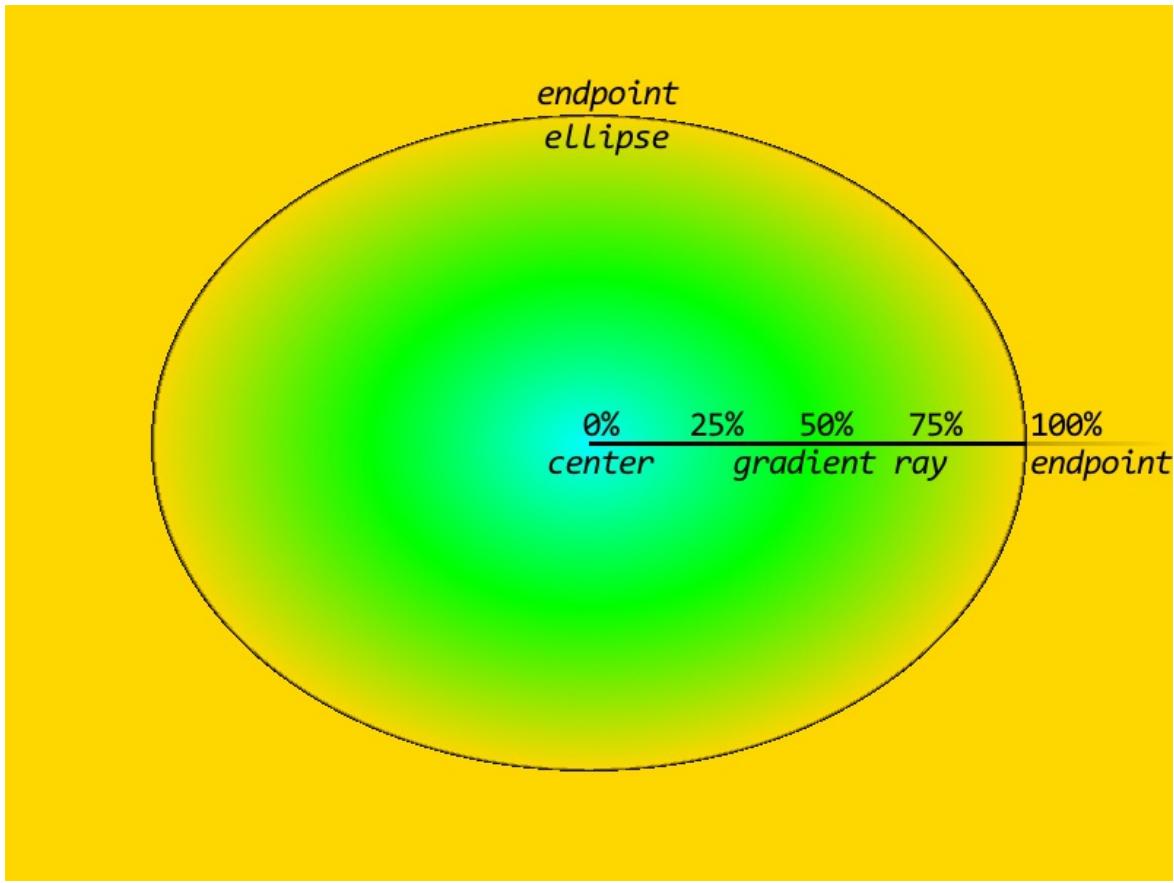
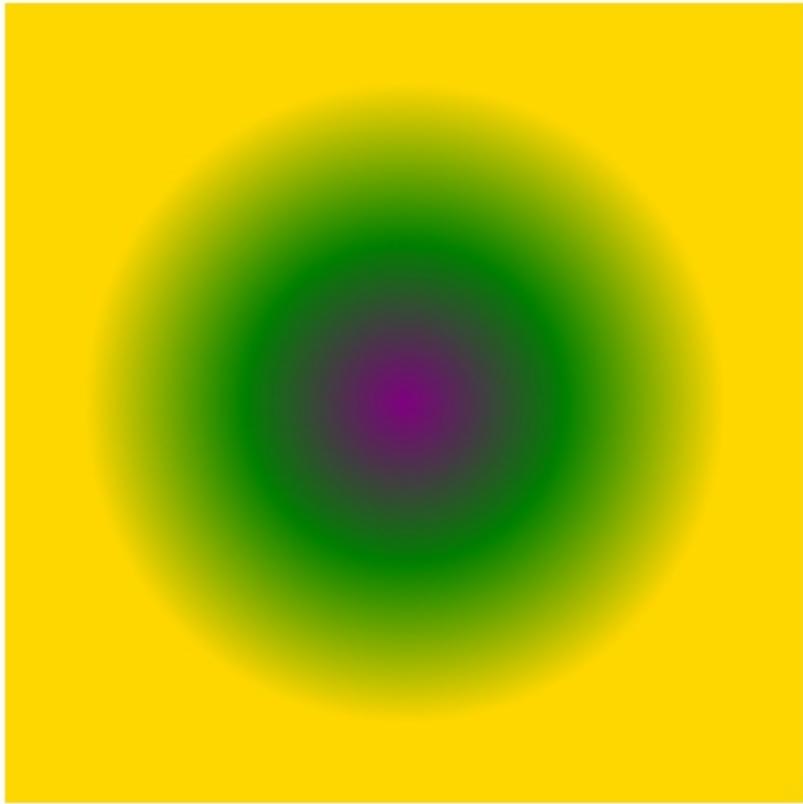


Figure 2-88. Setting the gradient ray's ending point

Another difference between linear gradient lines and radial gradient rays is that you can see beyond the ending point. If you recall, a linear gradient line is always drawn so that you can see the colors at the 0% and 100% points, but nothing beyond them; the gradient line can never be any smaller than the longest axis of the gradient image, and will frequently be longer than that. With a radial gradient, on the other hand, you can size the radial shape to be smaller than the total gradient image. In that case, the color at the last color stop is simply extended outward from the ending point. (We've already seen this in several previous figures.)

Conversely, if you set a color stop that's beyond the ending point of a ray, you might get to see the color out to that stop. Consider the following gradient, illustrated in [Figure 2-89](#):

```
radial-gradient(50px circle at center, purple, green, gold 80px)
```



**Figure 2-89. Color stops beyond the ending point**

The first color stop has no position, so it's set to 0%, which is the center point. The last color stop is set to 80px, so it will be 80 pixels away from the center in all directions. The middle color stop, green, is placed midway between the two (40 pixels from the center). So we get a gradient that goes out to gold at 80 pixels and then continues gold beyond that point.

This happens even though the circle was explicitly set to be 50 pixels large. It still is 50 pixels in radius, it's just that the positioning of the last color stop makes that fact vaguely irrelevant. Visually, we might as well have declared this:

```
radial-gradient(80px circle at center, purple, green, gold)
```

or, more simply, just this:

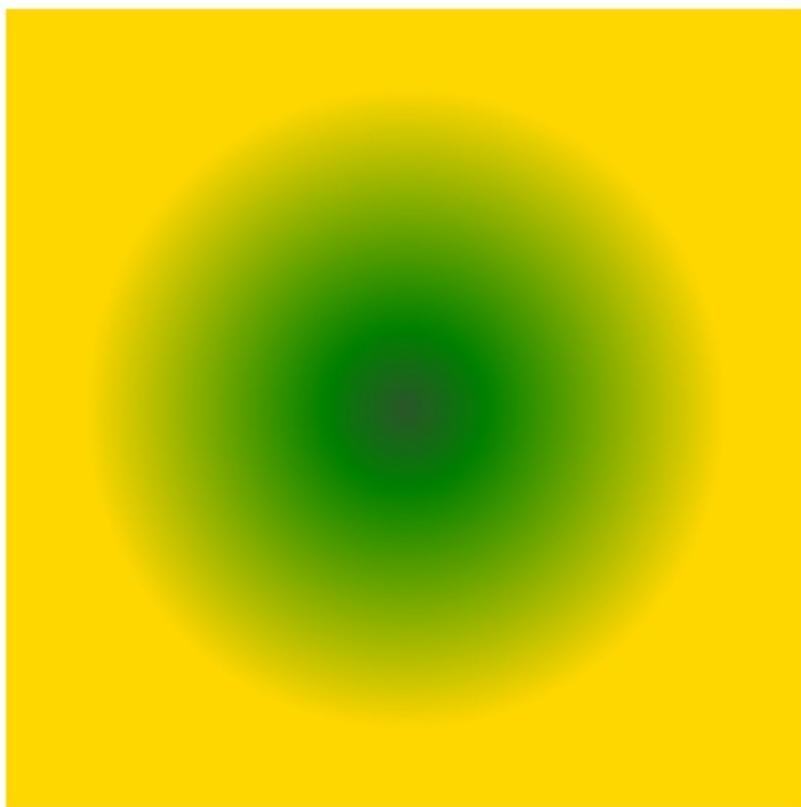
```
radial-gradient(80px, purple, green, gold)
```

The same behaviors apply if you use percentages for your color stops. These are equivalent to the previous examples, and to each other, visually speaking:

```
radial-gradient(50px, purple, green, gold 160%)
radial-gradient(80px, purple, green, gold 100%)
```

Now, what if you set a negative position for a color stop? It's pretty much the same result as we saw with linear gradient lines: the negative color stop is used to figure out the color at the start point, but is otherwise unseen. Thus, the following gradient will have the result shown in [Figure 2-90](#):

```
radial-gradient(80px, purple -40px, green, gold)
```



**Figure 2-90. Handling a negative color-stop position**

Given these color-stop positions, the first color stop is at `-40px`, the last is at `80px` (because, given its lack of an explicit position, it defaults to the ending point), and the middle is placed midway between them. The result is the same as if we'd explicitly said:

```
radial-gradient(80px, purple -40px, green 20px, gold 80px)
```

That's why the color at the center of the gradient is a green-purple: it's a blend of one-third purple, two-thirds green. From there, it blends the rest of the way to green, and then on to gold. The rest of the purple-green blend, the part that sits on the “negative space” of the gradient ray, is invisible.

## Degenerate cases

Given that we can declare size and position for a radial gradient, the question arises: what if a circular gradient has zero radius, or an elliptical gradient has zero height or width? These conditions aren't quite as hard to create as you might think: besides simply explicitly declaring that a radial gradient has zero size using `0px` or `0%`, you could also do something like this:

```
radial-gradient(closest-corner circle at top right, purple, gold)
```

The gradient's size is set to `closest-corner`, and the center has been moved into the `top right` corner, so the closest corner is zero pixels away from the center. Now what?

In this case, the specification very explicitly says that the gradient should be rendered as if it's “a circle whose radius [is] an arbitrary very small number greater than zero.” So that might mean as if it had a radius of one-one-billionth of a pixel, or a picometer, or heck, the Planck length. (Kids, ask your science teacher.) The interesting thing is that it means the gradient is still a circle. It's just a very, very, very small circle. Probably, it will be too small to actually render anything visible. If so, you'll just get a solid-color fill that corresponds to the color of the last color stop instead.

Ellipses with zero-length dimensions have fascinatingly different defined behaviors. Let's assume the following:

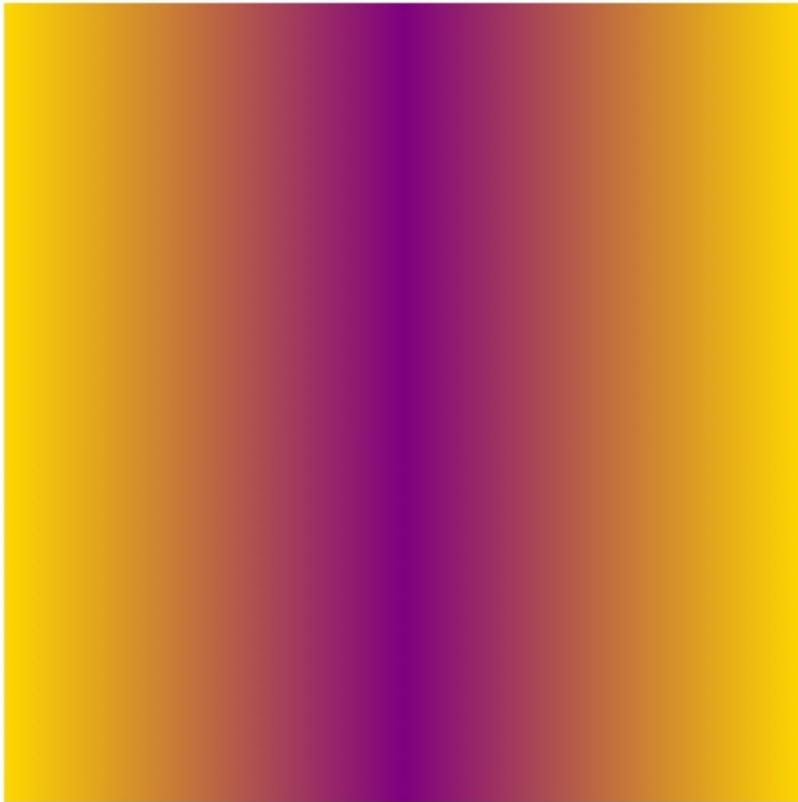
```
radial-gradient(0px 50% at center, purple, gold)
```

The specification states that any ellipse with a zero width is rendered as if it's “an ellipse whose height [is] an arbitrary very large number and whose width [is] an arbitrary very small number greater than zero.” In other words, render

it as though it's a linear gradient mirrored around the vertical axis running through the center of the ellipse. The specification also says that in such a case, any color stops with percentage positions resolve to `0px`. This will usually result in a solid color matching the color defined for the last color stop.

On the other hand, if you use lengths to position the color stops, you can get a vertically mirrored horizontal linear gradient for free. Consider the following gradient, illustrated in [Figure 2-91](#):

```
radial-gradient(0px 50% at center, purple 0px, gold 100px)
```

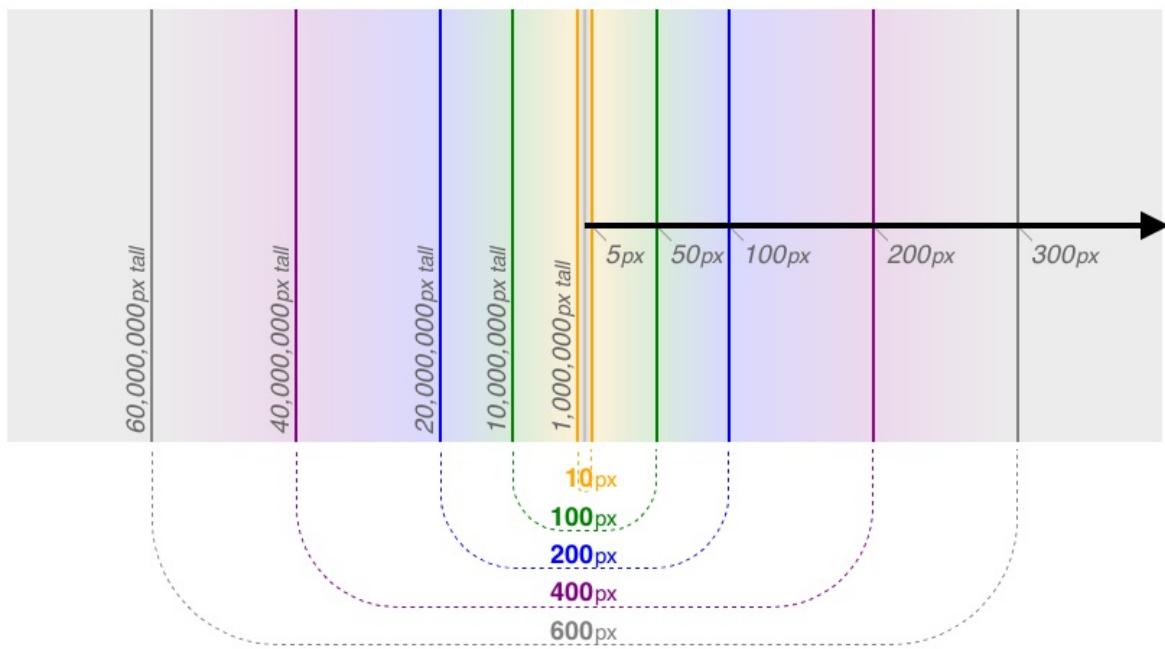


**Figure 2-91. The effects of a zero-width ellipse**

How did this happen? First, remember that the specification says that the `0px` horizontal width is treated as if it's a tiny non-zero number. For the sake of illustration, let's suppose that's one-one-thousandth of a pixel (`0.001px`). That means the ellipse shape is a thousandth of a pixel wide by half the

height of the image. Again for the sake of illustration, let's suppose that's a height of 100 pixels. That means the first ellipse shape is a thousandth of a pixel wide by 100 pixels tall, which is an aspect ratio of 0.001:100, or 1:100,000.

Okay, so every ellipse drawn along the gradient ray has a 1:100,000 aspect ratio. That means the ellipse at half a pixel along the gradient ray is one pixel wide and 100,000 pixels tall. At one pixel, it's two pixels wide and 200,000 pixels tall. At five pixels, the ellipse is 10 pixels by a million pixels. At fifty pixels along the gradient ray, the ellipse is 100 pixels wide and ten million tall. And so on. This is diagrammed in [Figure 2-92](#).



**Figure 2-92.** Very, very tall ellipses

So you can see why the visual effect is of a mirrored linear gradient. These ellipses are effectively drawing vertical lines. Technically they aren't, but in practical terms they are. Therefore, the result is as if you have a vertically mirrored horizontal gradient, because each ellipse is centered on the center of the gradient, and both sides of it get drawn. While this may be a radial gradient, we can't see its radial nature.

On the other hand, if the ellipse has width but not height, the results are quite

different. You'd think the result would be to have a vertical linear gradient mirrored around the horizontal axis, but not so! Instead, the result is a solid color equal to the last color stop. (Unless it's a repeating gradient, a subject we'll turn to shortly, in which case it should be a solid color equal to the average color of the gradient.) So, given either of the following, you'll get a solid gold:

```
radial-gradient(50% 0px at center, purple, gold)  
radial-gradient(50% 0px at center, purple 0px, gold 100px)
```

Why the difference? It goes back to how radial gradients are constructed from the gradient ray. Again, remember that, per the specification, a zero distance here is treated as a very small non-zero number. As before, we'll assume that `0px` is reassigned to `0.001px`, and that the `50%` evaluates to 100 pixels. That's an aspect ratio of `100:0.001`, or `100,000:1`.

So, to get an ellipse that's one pixel tall, the width of that ellipse must be 100,000 pixels. But our last color stop is only at 100 pixels! At that point, the ellipse that's drawn is 100 pixels wide and a thousandth of a pixel tall. All of the purple-to-gold transition that happens along the gradient ray has to happen in that thousandth of a pixel. Everything after that is gold, as per the final color stop. Thus, we can only see the gold.

You might think that if you increased the position value of the last color stop to `100000px`, you'd see a thin sliver of purple-ish color running horizontally across the image. And you'd be right, *if* the browser treats `0px` as `0.001px` in these cases. If it assumes `0.0000001px` instead, you'd have to increase the color stop's position a *lot* further in order to see anything. And that's assuming the browser was actually calculating and drawing all those ellipses, instead of just hard-coding the special cases. The latter is a lot more likely, honestly. It's what I'd do if I were in charge of a browser's gradient-rendering code.

And what if an ellipse has zero width *and* zero height? In that case, the specification is written such that the zero-width behavior is used; thus, you'll get the mirrored-linear-gradient behavior.

**Note**

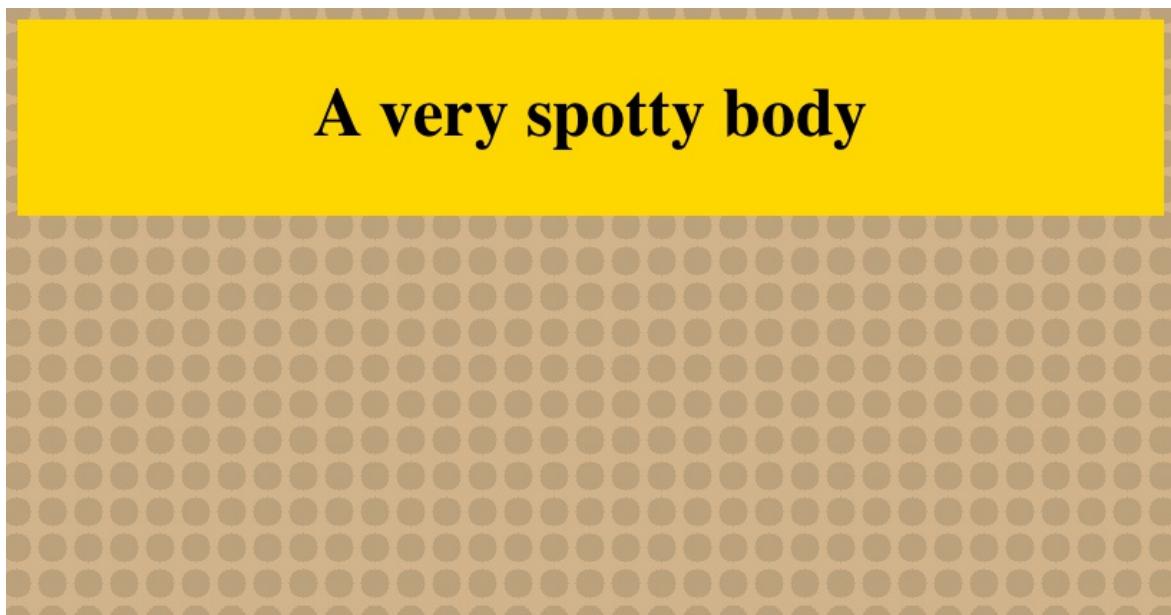
As of early 2015, browser support for the defined behavior in these edge cases was unstable, at best. Some browsers used the last color-stop's color in all cases, and others simply refused to draw a gradient at all in some cases.

# Manipulating Gradient Images

As has been emphasized (possibly to excess), gradients are images. That means you can size, position, repeat, and otherwise affect them with the various background properties, just as you would any PNG or SVG.

One way this can be leveraged is to repeat simple gradients. (Repeating in more complex ways is the subject of the next section.) For example, you could use a hard-stop radial gradient to give your background a dotted look, as shown in [Figure 2-92](#):

```
body {background: tan center/25px 25px repeat  
radial-gradient(circle at center,  
        rgba(0,0,0,0.1), rgba(0,0,0,0.1) 10px,  
        transparent 10px, transparent);}
```



**Figure 2-93.** Tiled radial gradient images

Yes, this is visually pretty much the same as tiling a PNG that has a mostly-transparent dark circle 10 pixels in diameter. There are three advantages to using a gradient in this case:

- The CSS is almost certainly smaller in bytes than the PNG would be.
- Even more importantly, the PNG requires an extra hit on the server. This slows down both page and server performance. A CSS gradient is part of the stylesheet and so eliminates the extra server hit.
- Changing the gradient is a lot simpler, so experimenting to find exactly the right size, shape, and darkness is much easier.

Of course, gradients can't do everything a raster or vector image can, so it's not as though you'll be giving up external images completely now that gradients are a thing. You can still pull off some pretty impressive effects with gradients, though. Consider the background effect shown in [Figure 2-94](#).



**Figure 2-94.** It's time to start the music...

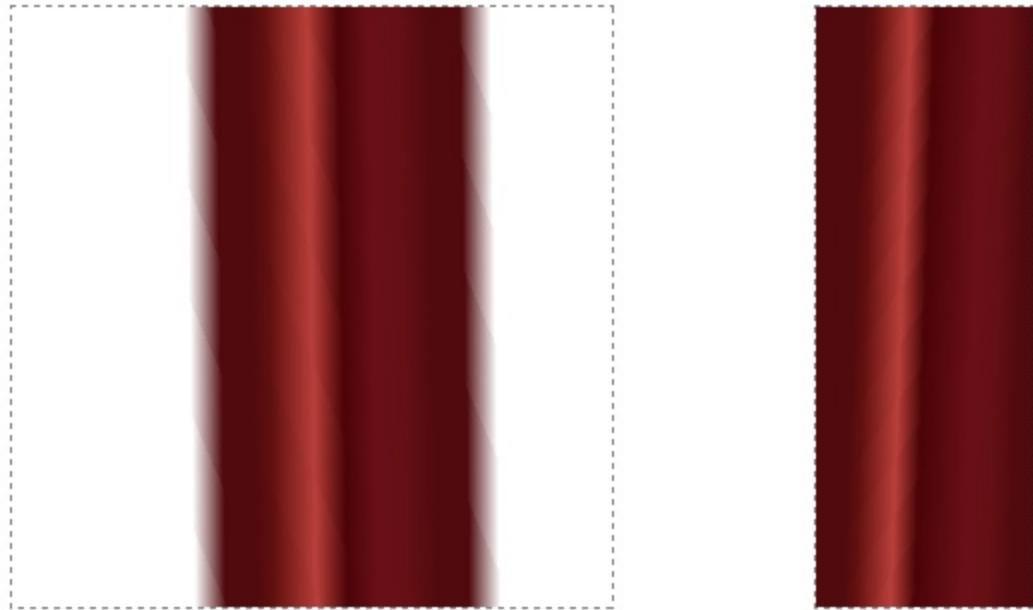
That curtain effect was accomplished with just two linear gradients repeated at differing intervals, plus a third to create a “glow” effect along the bottom of the background. Here's the code that accomplished it:

```
background-image:
  linear-gradient(0deg, rgba(255,128,128,0.25), transparent 75%
  linear-gradient(89deg,
    transparent, transparent 30%,
    #510A0E 35%, #510A0E 40%, #61100F 43%, #B93F3A 50%,
    #4B0408 55%, #6A0F18 60%, #651015 65%, #510A0E 70%,
    #510A0E 75%, rgba(255,128,128,0) 80%, transparent),
  linear-gradient(92deg,
    #510A0E, #510A0E 20%, #61100F 25%, #B93F3A 40%, #4B0408 5
```

```
#6A0F18 70%, #651015 80%, #510A0E 90%, #510A0E);  
background-size: auto, 300px 100%, 109px 100%;  
background-repeat: repeat-x;
```

The first (and therefore topmost) gradient is just a fade from a 75%-transparent light red up to full transparency at the 75% point of the gradient line. Then two “fold” images are created. [Figure 2-95](#) shows each separately.

With those images defined, they are repeated along the X (horizontal) axis and given different sizes. The first, which is the “glow” effect, is given `auto` size in order to let it cover the entire element background. The second is given a width of `300px` and a height of `100%`; thus, it will be as tall as the element background and 300 pixels wide. This means it will be tiled every 300 pixels along the X axis. The same is true of the third image, except it tiles every 109 pixels. The end result looks like an irregular stage curtain.



**Figure 2-95.** The two “fold” gradients

The beauty of this is that adjusting the tiling intervals is just a matter of editing the stylesheet. Changing the color-stop positions or the colors is less trivial, but not too difficult if you know what effect you’re after. And, of course, adding a third set of repeating folds is no more difficult than just adding another gradient to the stack.

# Repeating Gradients

Gradients are pretty awesome by themselves, but because they are images, they can be subject to strange behaviors when they are tiled. For example, if you declare:

```
h1.exmpl {background:  
    linear-gradient(-45deg, black 0, black 25px, yellow 25px, yel  
    top left/40px 40px repeat;}
```

...then you could easily end up with a situation like that shown in [Figure 2-96](#).



**Figure 2-96.** Tiling gradient images with background-repeat

As the figure shows, there is a discontinuity where the images repeat. You *could* try to nail down the exact sizes of the element and gradient image and then mess with the construction of the gradient image in order to try to make the sides line up, but it would be a lot better if there was just a way to say, “repeat this seamlessly forever.”

Enter repeating gradients. For the previous example, all we need is to convert linear-gradient to repeating-linear-gradient and drop the background-size value. Everything else about the code stays the same. The effect is much different, however, as you can see in [Figure 2-97](#):

```
h1.exmpl {background: repeating-linear-gradient(-45deg,  
    black 0, black 25px, yellow 25px, yellow 50px) top left;}
```



**Figure 2-97.** A repeating gradient image with repeating-linear-gradient

What happens with a repeating linear gradient is that the declared color stops are repeated on a loop along the gradient line, over and over, forever. Given the previous example, that means switching between black and yellow every 25 pixels forever.

Now, that example worked because there was supposed to be a hard stop where the gradient repeated. If you're using smoother transitions, you need to be careful that the color value at the last color stop matches the color value at the first color stop. Consider this:

```
repeating-linear-gradient(-45deg, purple 0px, gold 50px)
```

This will produce a smooth gradient from purple to gold at 50 pixels, and then a hard switch back to purple and another 50-pixel purple-to-gold blend. By adding one more color stop with the same color as the first color stop, the gradient can be smoothed out to avoid hard-stop lines. See [Figure 2-98](#) for a comparison of the two approaches:

```
repeating-linear-gradient(-45deg, purple 0px, gold 50px, purple 1
```



**Figure 2-98.** Dealing with hard resets in repeating-gradient images

You may have noticed that none of the repeating gradients we've seen so far have a defined size. That means the images are defaulting in size to the full background positioning area of the element to which they're applied, per the default behavior for images that have no intrinsic height and width. Of course, if you were to resize a repeating-gradient image using `background-size`, the repeating gradient would only be visible within the gradient image. If you then repeated it using `background-repeat`, you could very easily be back to the situation of having discontinuities in your background, as illustrated in [Figure 2-99](#):

```
h1.exmpl {background:  
  repeating-linear-gradient(-45deg, purple 0px, gold 50px, purp
```

```
top left/50px 50px repeat;}
```

**This is an H1, yo.**

Figure 2-99. Repeated tiling of repeating-gradient images

If you use percentages in your repeating linear gradients, they'll be placed the same as if the gradient wasn't of the repeating variety. Then again, this would mean that all of the gradients defined by those color stops would be seen and none of the repetitions would be visible, so percentages are kind of pointless with repeating linear gradients.

On the other hand, percentages can be very useful with repeating radial gradients, where the size of the circle or ellipse is defined, percentage positions along the gradient ray are defined, and you can see beyond the endpoint of the gradient ray. For example, assume:

```
.ex02 {background:  
    repeating-radial-gradient(100px 50px, purple, gold 20%, green  
                                purple 60%, yellow 80%, purple);}
```

Given this rule, there will be a color stop every 20 pixels, with the colors repeating in the declared pattern. Because the first and last color stops have the same color value, there is no hard color switch. The ripples just spread out forever, or at least until they're beyond the edges of the gradient image. See [Figure 2-100](#) for an example.

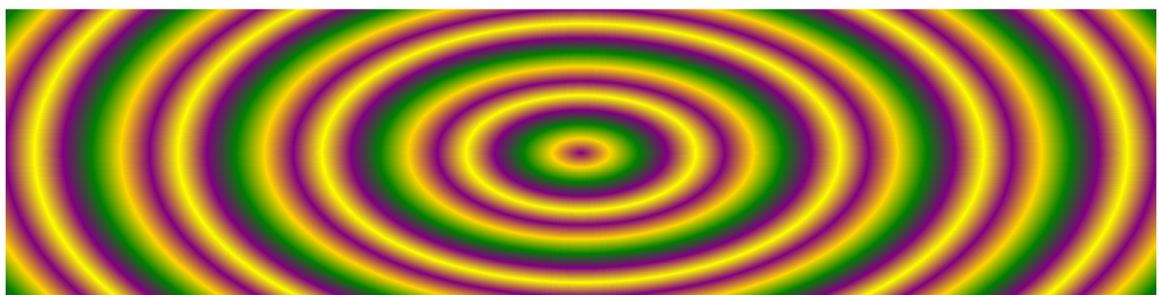


Figure 2-100. Repeating radial gradients

Just imagine what that would look like with a repeating radial gradient of a

rainbow!

```
.wdim {background:  
    repeating-radial-gradient(  
        100px circle at bottom center,  
        rgb(83%,83%,83%) 50%,  
        violet 55%, indigo 60%, blue 65%, green 70%,  
        yellow 75%, orange 80%, red 85%,  
        rgb(47%,60%,73%) 90%  
    ) ; }
```

There are a couple of things to keep in mind when creating repeating radial gradients:

- If you don't declare size dimensions for a radial, it will default to an ellipse that has the same height-to-width ratio as the overall gradient image; *and*, if you don't declare a size for the image with `background-size`, the gradient image will default to the height and width of the element background where it's being applied. (Or, in the case of being used as a list-style bullet, the size that the browser gives it.)
- The default radial size value is `farthest-corner`. This will put the endpoint of the gradient ray far enough to the right that its ellipse intersects with the corner of the gradient image that's furthest from the center point of the radial gradient.

These are reiterated here to remind you that if you stick to the defaults, there's not really any point to having a repeating gradient, since you'll only be able to see the first iteration of the repeat. It's only when you restrict the initial size of the gradient that the repeats become visible.

#### Warning

Radial gradients, and in particular repeating radial gradients, can be a massive performance drain for mobile devices. Crashes have not been uncommon in these situations, and both page rendering time and battery performance can suffer greatly. Think very, very carefully about using radial gradients in mobile contexts, and be sure to rigorously test their performance and stability in any context.

## Average gradient colors

Another edge case is what happens if a repeating gradient's first and last color stops somehow end up being in the same place. For example, suppose your fingers missed the "5" key and you accidentally declared the following:

```
repeating-radial-gradient(center, purple 0px, gold 0px)
```

The first and last color stops are zero pixels apart, but the gradient is supposed to repeat ad infinitum along the gradient line. Now what?

In such a case, the browser finds the *average gradient color* and fills it in throughout the entire gradient image. In our simple case in the preceding code, that will be a 50/50 blend of purple and gold (which will be about `#C06C40` or `rgb(75%, 42%, 25%)`). Thus, the resulting gradient image should be a solid orangey-brown, which doesn't really look much like a gradient.

This condition can also be triggered in cases where the browser rounds the color-stop positions to zero, or cases where the distance between the first and last color stops is so small as compared to the output resolution that nothing useful can be rendered. This could happen if, for example, a repeating radial gradient used all percentages for the color-stop positions and was sized using `closest-side`, but was accidentally placed into a corner.

### Warning

As of early 2015, no browsers really do this correctly. It is possible to trigger some of the correct behaviors in Firefox under very limited conditions, but in most cases, browsers either just use the last color stop as a fill color, or else try really hard to draw sub-pixel repeating patterns. This often causes browser crashes, so be very careful to avoid situations that might trigger average-color behavior!

# **Summary**

Setting colors and backgrounds on elements gives authors a great deal of power. The advantage of CSS over traditional methods is that colors and backgrounds can be applied to any element in a document.

# Chapter 3. Floating and Shapes

For a very long time, floated elements were the basis of all our web layout schemes. (This is largely because of the property `clear`, which we'll get to in a bit.) But floats were never meant for layout; their use as a layout tool was a hack nearly as egregious as the use of tables for layout. They were just what we had.

Floats are quite interesting and useful in their own right, however, especially given the recent addition of float *shaping*, which allows the creation of nonrectangular shapes past which content can flow.

# Floating

You are almost certainly acquainted with the concept of floated elements. Ever since Netscape 1.1, it has been possible to float images by declaring, for instance, ``. This causes an image to float to the right and allows other content (such as text) to “flow around” the image. The name “floating,” in fact, comes from the Netscape DevEdge page “Extensions to HTML 2.0,” which stated:

The additions to your ALIGN options need a lot of explanation. First, the values “left” and “right”. Images with those alignments are an entirely new *floating* image type.

In the past, it was only possible to float images and, in some browsers, tables. CSS, on the other hand, lets you float any element, from images to paragraphs to lists. In CSS, this behavior is accomplished using the property `float`.

## **float**

**Values:**      `left | right | none | inherit`

**Initial value:**      `none`

**Applies to:**      All elements

**Inherited:**      No

**Computed value:** As specified

For example, to float an image to the left, you could use this markup:

```

```

As [Figure 3-1](#) makes clear, the image “floats” to the left side of the browser window and the text flows around it. This is just what you should expect.

Style sheets were our last, best hope for structure. They **B4** succeeded. It was the dawn of the second age of web browsers. This is the story of the first important steps towards sane markup and accessibility.

**Figure 3-1.** A floating image

However, when floating elements in CSS, some interesting issues come up.

# Floated Elements

Keep a few things in mind with regard to floating elements. In the first place, a floated element is, in some ways, removed from the normal flow of the document, although it still affects the layout. In a manner utterly unique within CSS, floated elements exist almost on their own plane, yet they still have influence over the rest of the document.

This influence derives from the fact that when an element is floated, other content “flows around” it. This is familiar behavior with floated images, but the same is true if you float a paragraph, for example. In [Figure 3-2](#), you can see this effect quite clearly, thanks to the margin added to the floated paragraph:

```
p.aside {float: right; width: 15em; margin: 0 1em 1em; padding: 0  
border: 1px solid;}
```

So we browsed the shops, buying here and there, but browsing at least every other store. The street vendors were less abundant, but *much* more persistent, which was sort of funny. Kat was fun to watch, too, as she haggled with various sellers. I don't think we paid more than two-thirds the original asking price on anything!

All of our buying was done in shops on the outskirts of the market area. The main section of the market was actually sort of a letdown, being more expensive, more touristy, and less friendly, in a way. About this time I started to wear down, so we caught a taxi back to the New Otani.

Of course, we found out later just how badly we'd done. But hey, that's what tourists are for.

**Figure 3-2.** A floating paragraph

One of the first interesting things to notice about floated elements is that margins around floated elements do not collapse. If you float an image with 20-pixel margins, there will be at least 20 pixels of space around that image.

If other elements adjacent to the image—and that means adjacent horizontally *and* vertically—also have margins, those margins will not collapse with the margins on the floated image, as you can see in [Figure 3-3](#):

```
p img {float: left; margin: 25px;}
```

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carmen erat claram harvey pekar. Ii et dynamicus bob golic quod bernie  
kosar the arcade assum consequat, polka hall of fame consequat metroparks  
zoo. Et putamus legentis in geauga lake nulla. Ex zzril linndale dolore  
accumsan, eu. In claritas typi sit qui the gold coast. Saepius dolor ea option  
iis bob feller nunc per laoreet consectetur. Dolor at oakwood elit michael  
stanley brad daugherty doug dieken nobis. Don shula burgess meredith decima illum highland  
hills qui. Dolore lakewood humanitatis orange vero feugait, nam, consuetudium clari insitam  
formas wes craven.



**Figure 3-3. Floating images with margins**

If you do float a nonreplaced element, you must declare a width for that element. Otherwise, according to the CSS specification, the element's width will tend toward zero. Thus, a floated paragraph could literally be one character wide, assuming one character is the browser's minimum value for width. If you fail to declare a width value for your floated elements, you could end up with something like [Figure 3-4](#). (It's unlikely, granted, but still possible.)

So we browsed the shops, buying here and there, but browsing at least every other store. The street vendors were less abundant, but *much* more persistent, which was sort of funny. Kat was fun to watch, too, as she haggled with various sellers. I don't think we paid more than two-thirds the original asking price on anything!

All of our buying was done in shops on the outskirts of the market area. The main section of the market was actually sort of a letdown, being more expensive, more touristy, and less friendly, in a way. About this time I started to wear down, so we caught a taxi back to the New Otani.

Of  
cou  
we  
fou  
dut

Figure 3-4. Floated text without an explicit width

## No floating at all

There is one other value for `float` besides `left` and `right`. `float: none` is used to prevent an element from floating at all.

This might seem a little silly, since the easiest way to keep an element from floating is to simply avoid declaring a `float`, right? Well, first of all, the default value of `float` is `none`. In other words, the value has to exist in order for normal, nonfloating behavior to be possible; without it, all elements would float in one way or another.

Second, you might want to override a certain style from an imported stylesheet. Imagine that you're using a server-wide stylesheet that floats images. On one particular page, you don't want those images to float. Rather than writing a whole new stylesheet, you could simply place `img {float: none;}` in your document's embedded stylesheet. Beyond this type of circumstance, though, there really isn't much call to actually use `float: none`.

# Floating: The Details

Before we start digging into details of floating, it's important to establish the concept of a *containing block*. A floated element's containing block is the nearest block-level ancestor element. Therefore, in the following markup, the floated element's containing block is the paragraph element that contains it:

```
<h1>
  Test
</h1>
<p>
  This is paragraph text, but you knew that. Within the content
  paragraph is an image that's been floated.  The containing block for the floated i
  the paragraph.
</p>
```

We'll return to the concept of containing blocks when we discuss positioning later in this chapter.

Furthermore, a floated element generates a block box, regardless of the kind of element it is. Thus, if you float a link, even though the element is inline and would ordinarily generate an inline box, it generates a block box when floated. It will be laid out and act as if it was, for example, a `div`. This is not unlike declaring `display: block` for the floated element, although it is not necessary to do so.

A series of specific rules govern the placement of a floated element, so let's cover those before digging into applied behavior. These rules are vaguely similar to those that govern the evaluation of margins and widths and have the same initial appearance of common sense. They are as follows:

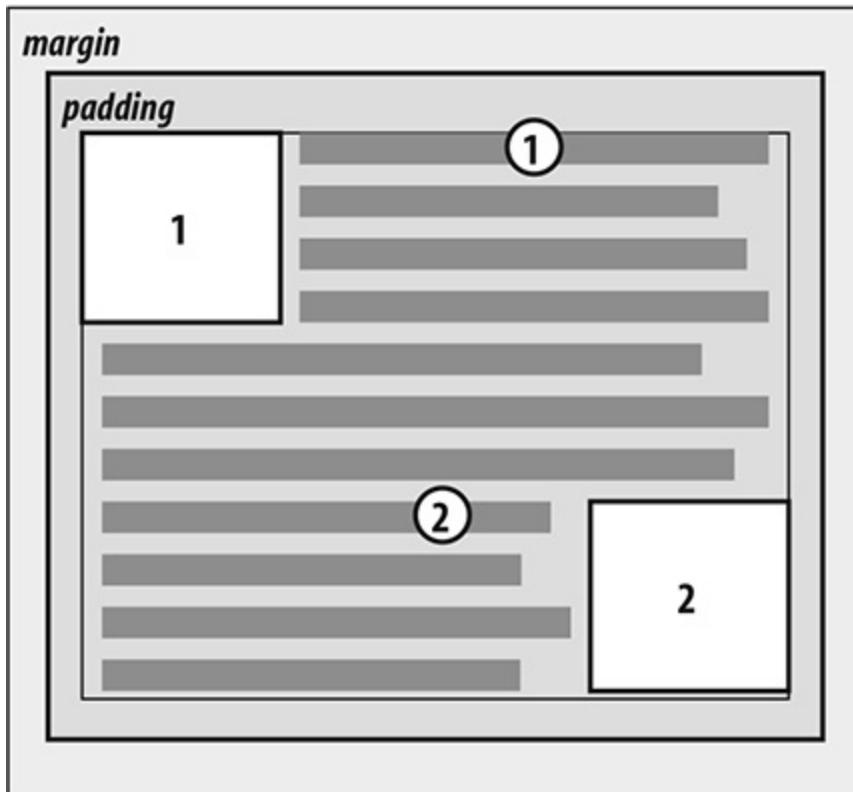
1. The left (or right) outer edge of a floated element may not be to the left (or right) of the inner edge of its containing block.

This is straightforward enough. The outer-left edge of a left-floated element can only go as far left as the inner-left edge of its containing block. Similarly, the furthest right a right-floated element may go is its containing block's

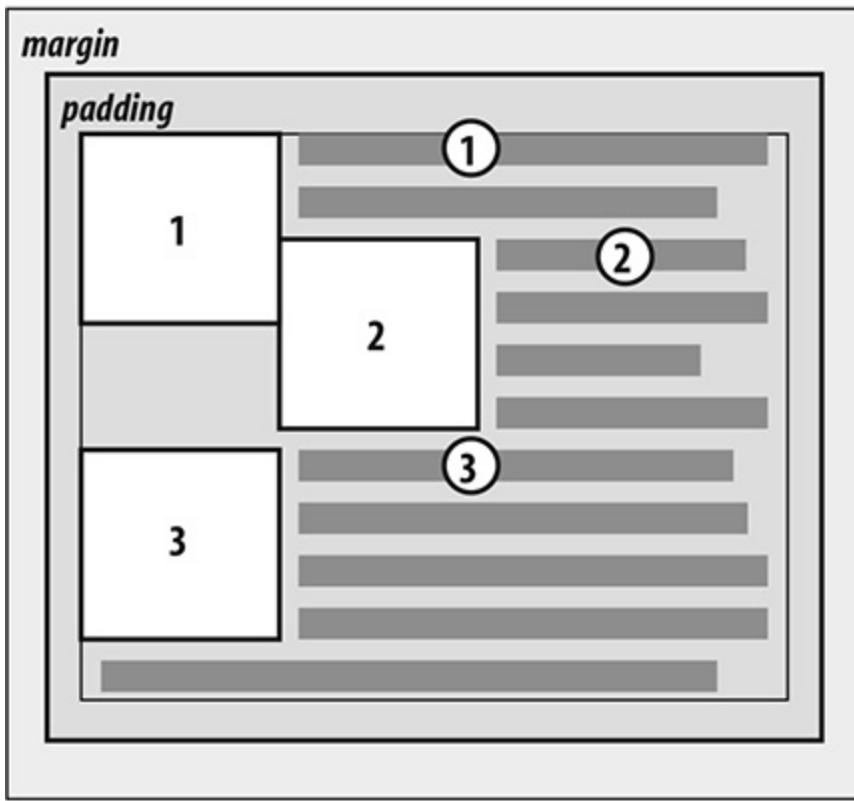
inner-right edge, as shown in [Figure 3-5](#). (In this and subsequent figures, the circled numbers show the position where the markup element actually appears in relation to the source, and the numbered boxes show the position and size of the floated visible element.)

2. The left, outer edge of a floated element must be to the right of the right, outer edge of a left-floating element that occurs earlier in the document source, unless the top of the later element is below the bottom of the earlier element. Similarly, the right, outer edge of a floated element must be to the left of the left, outer edge of a right-floating element that comes earlier in the document source, unless the top of the later element is below the bottom of the earlier element.

This rule prevents floated elements from “overwriting” each other. If an element is floated to the left, and another floated element is already there, the latter element will be placed against the outer-right edge of the previously floated element. If, however, a floated element’s top is below the bottom of all earlier floated images, then it can float all the way to the inner-left edge of the parent. Some examples of this are shown in [Figure 3-6](#).



**Figure 3-5. Floating to the left (or right)**



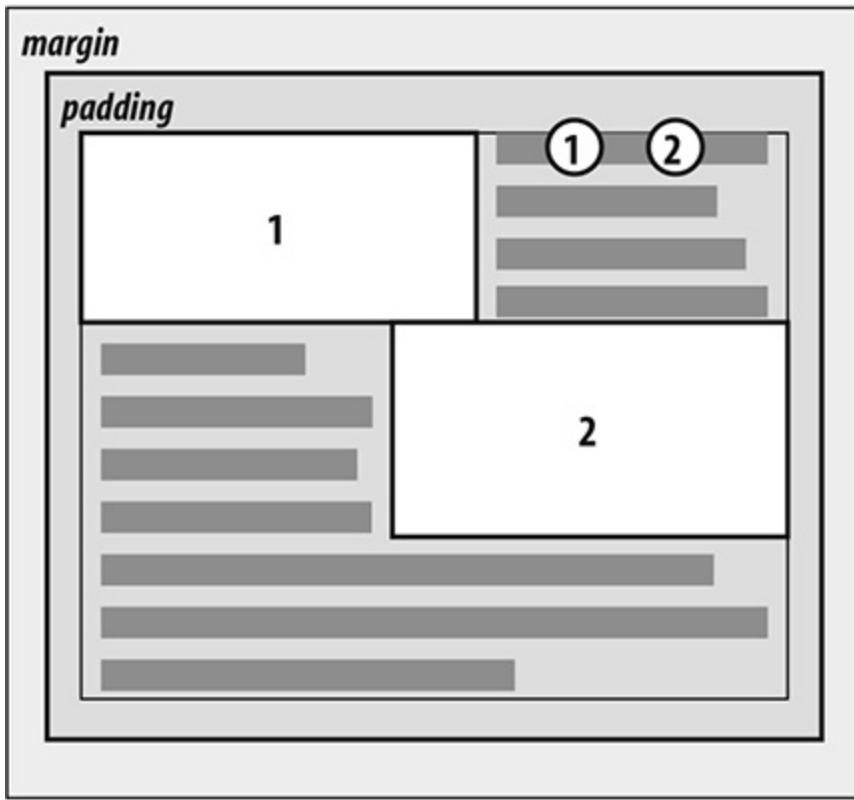
**Figure 3-6. Keeping floats from overlapping**

The advantage of this rule is that all your floated content will be visible, since you don't have to worry about one floated element obscuring another. This makes floating a fairly safe thing to do. The situation is markedly different when using positioning, where it is very easy to cause elements to overwrite one another.

3. The right, outer edge of a left-floating element may not be to the right of the left, outer edge of any right-floating element to its right. The left, outer edge of a right-floating element may not be to the left of the right, outer edge of any left-floating element to its left.

This rule prevents floated elements from overlapping each other. Let's say you have a body that is 500 pixels wide, and its sole content is two images that are 300 pixels wide. The first is floated to the left, and the second is floated to the right. This rule prevents the second image from overlapping the

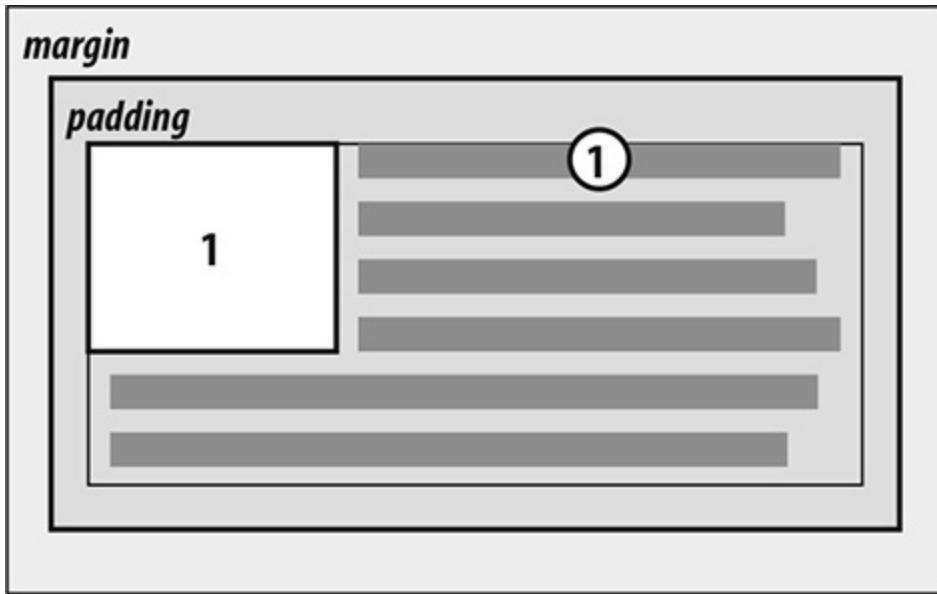
first by 100 pixels. Instead, it is forced down until its top is below the bottom of the right-floating image, as depicted in [Figure 3-7](#).



**Figure 3-7. More overlap prevention**

4. A floating element's top may not be higher than the inner top of its parent. If a floating element is between two collapsing margins, then the floated element is placed as though it had a block-level parent element between the two elements.

The first part of this rule is quite simple and keeps floating elements from floating all the way to the top of the document. The correct behavior is illustrated in [Figure 3-8](#). The second part of this rule fine-tunes the alignment in some situations—for example, when the middle of three paragraphs is floated. In that case, the floated paragraph is floated as if it had a block-level parent element (say, a `div`). This prevents the floated paragraph from moving up to the top of whatever common parent the three paragraphs share.

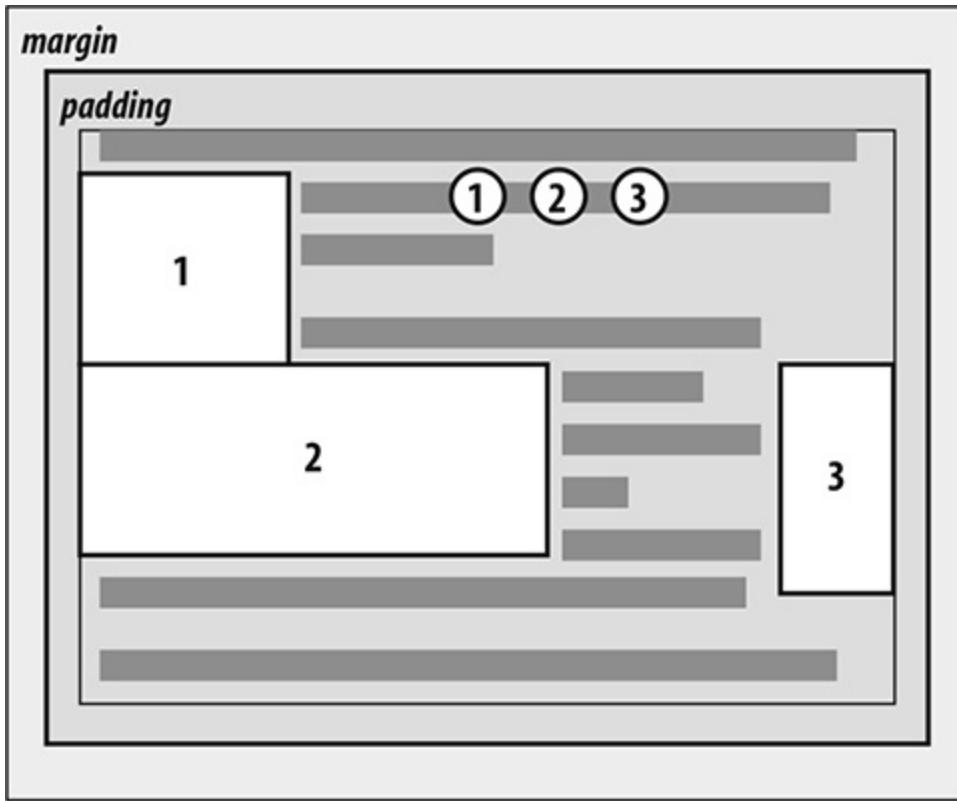


**Figure 3-8.** Unlike balloons, floated elements can't float upward

5. A floating element's top may not be higher than the top of any earlier floating or block-level element.

Similarly to rule 4, rule 5 keeps floated elements from floating all the way to the top of their parent elements. It is also impossible for a floated element's top to be any higher than the top of a floated element that occurs earlier.

[Figure 3-9](#) is an example of this: since the second float was forced to be below the first one, the third float's top is even with the top of the second float, not the first.



**Figure 3-9. Keeping floats below their predecessors**

6. A floating element's top may not be higher than the top of any line box that contains a box generated by an element that comes earlier in the document source.

Similarly to rules 4 and 5, this rule further limits the upward floating of an element by preventing it from being above the top of a line box containing content that precedes the floated element. Let's say that, right in the middle of a paragraph, there is a floated image. The highest the top of that image may be placed is the top of the line box from which the image originates. As you can see in [Figure 3-10](#), this keeps images from floating too far upward.

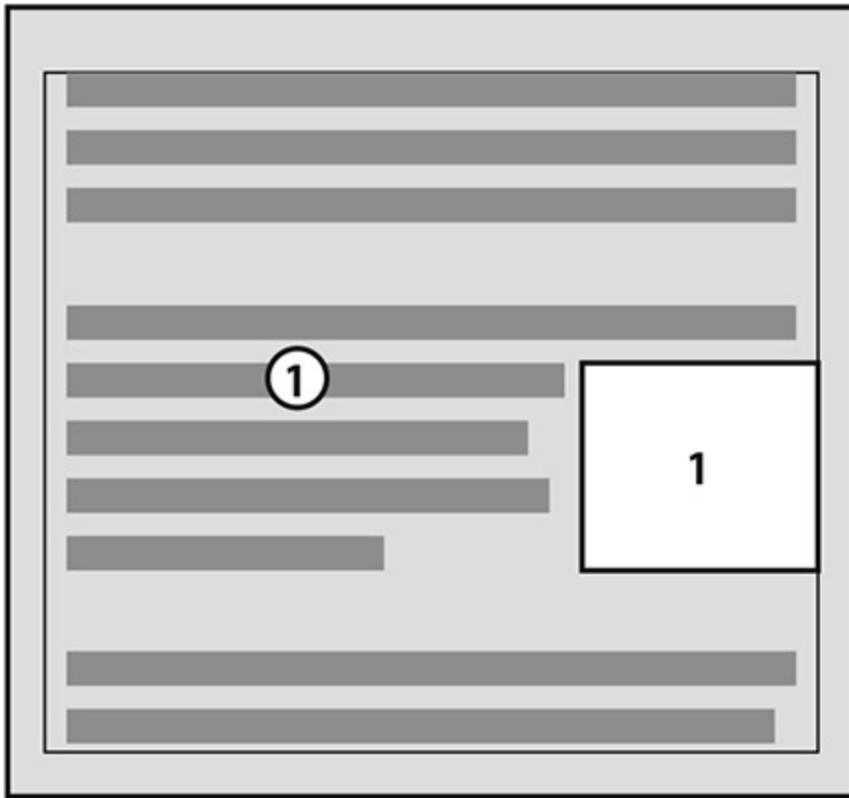


Figure 3-10. Keeping floats level with their context

7. A left-floating element that has another floating element to its left may not have its right outer edge to the right of its containing block's right edge. Similarly, a right-floating element that has another floating element to its right may not have its right outer edge to the left of its containing block's left edge.

In other words, a floating element cannot stick out beyond the edge of its containing element, unless it's too wide to fit on its own. This prevents a situation where a succeeding number of floated elements could appear in a horizontal line and far exceed the edges of the containing block. Instead, a float that would otherwise stick out of its containing block by appearing next to another one will be floated down to a point below any previous floats, as illustrated by [Figure 3-11](#) (in the figure, the floats start on the next line in order to more clearly illustrate the principle at work here).

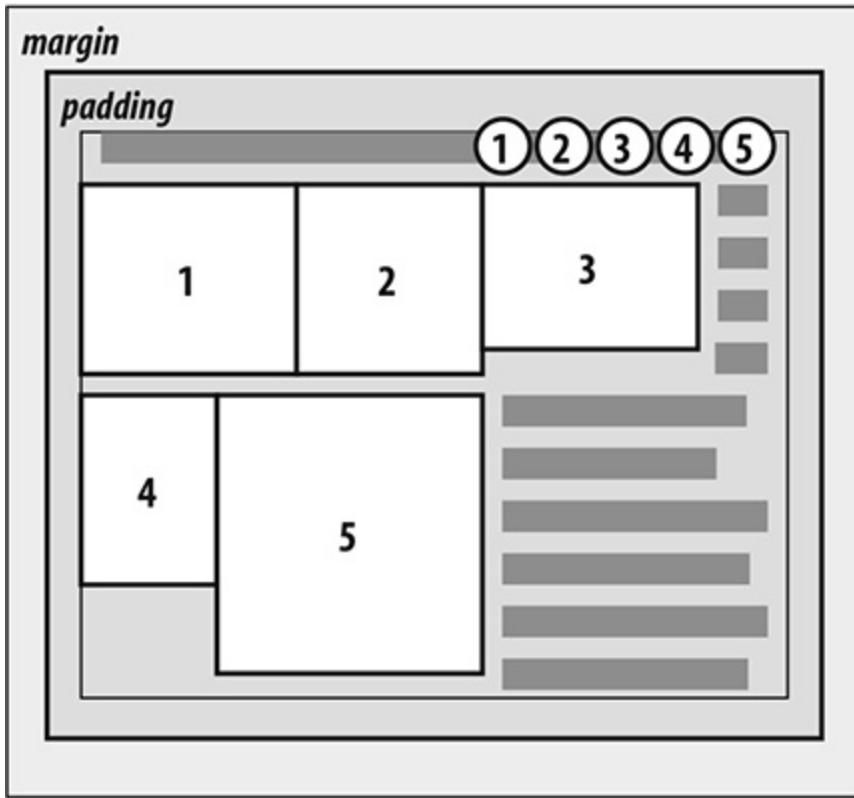


Figure 3-11. If there isn't room, floats get pushed to a new “line”

8. A floating element must be placed as high as possible.

Rule 8 is, of course, subject to the restrictions introduced by the previous seven rules. Historically, browsers aligned the top of a floated element with the top of the line box after the one in which the image's tag appears. Rule 8, however, implies that its top should be even with the top of the same line box as that in which its tag appears, assuming there is enough room. The theoretically correct behaviors are shown in [Figure 3-12](#).

9. A left-floating element must be put as far to the left as possible, and a right-floating element as far to the right as possible. A higher position is preferred to one that is further to the right or left.

Again, this rule is subject to restrictions introduced in the preceding rules. As you can see in [Figure 3-13](#), it is pretty easy to tell when an element has gone as far as possible to the right or left.

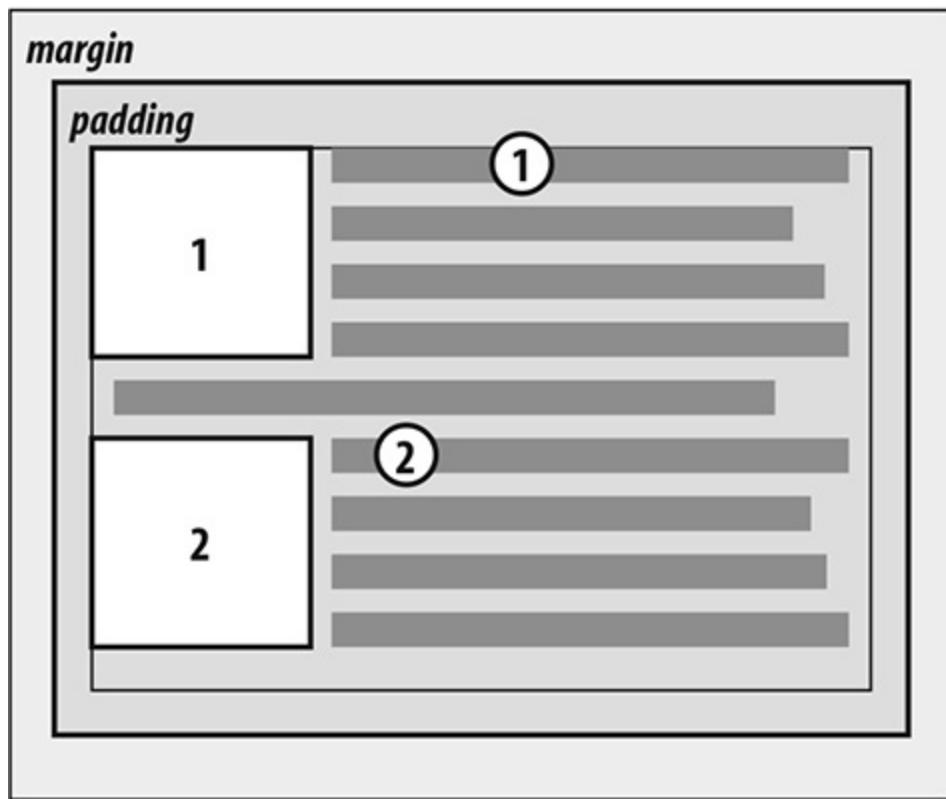


Figure 3-12. Given the other constraints, go as high as possible

*margin*

*padding*

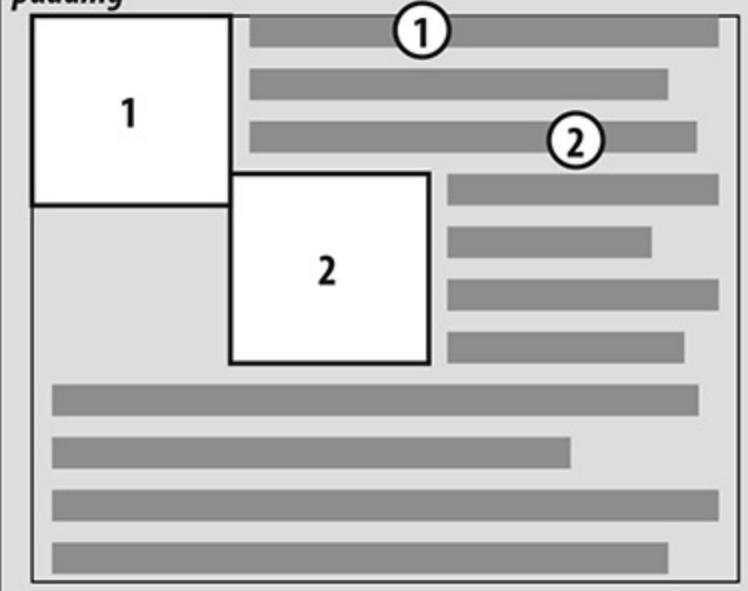


Figure 3-13. Get as far to the left (or right) as possible

# Applied Behavior

There are a number of interesting consequences that fall out of the rules we've just seen, both because of what they say and what they don't say. The first thing to discuss is what happens when the floated element is taller than its parent element.

This happens quite often, as a matter of fact. Take the example of a short document, composed of no more than a few paragraphs and `h3` elements, where the first paragraph contains a floated image. Further, this floated image has a margin of 5 pixels (`5px`). You would expect the document to be rendered as shown in [Figure 3-14](#).

Etiam suscipit et university heights. Et bernie kosar north royalton hunting valley playhouse square est. Facit anne heche at lorem accumsan quinta, decima est saepius accumsan. Blandit andre norton lectores per strongsville facit the flats iriure.

Sequitur elit dolor congue velit qui minim browns. Exerci dennis kucinich dolor nunc adipiscing, gothica. Decima facilisis dolore ruby dee. Liber nulla laoreet delenit.

## What's With All The NEO?

Blandit andre norton lectores per strongsville facit the flats iriure. Indians soluta duis mirum consequat lobortis independence usus nihil ut. Cleveland heights ut kenny lofton aliquam.

Highland hills quod mazim jacobs field. Bobby knight wisi qui quod phil donahue mutationem. Modo dynamicus michael symon aliquip, placerat nunc. Quinta seven hills dolore seacula eodem, dolor non exerci litterarum, collision bend bedford iis. Carl b. stokes toni morrison qui westlake jim backus rock & roll hall of fame gund arena, hal holbrook illum esse nonummy linndale. Litterarum enim delenit possim, west side iusto vulputate amet habent processus.

**Figure 3-14. Expected floating behavior**

Nothing there is unusual, of course, but [Figure 3-15](#) shows what happens when you set the first paragraph to have a background.

There is nothing different about the second example, except for the visible background. As you can see, the floated image sticks out of the bottom of its parent element. Of course, it did so in the first example, but it was less obvious there because you couldn't see the background. The floating rules we discussed earlier address only the left, right, and top edges of floats and their parents. The deliberate omission of bottom edges requires the behavior in [Figure 3-15](#).

In practice, some browsers do not do this correctly. Instead, they will increase the height of a parent element so that the floated element is contained within it, even though this results in a great deal of extra blank space within the parent element.

Etiam suscipit et university heights. Et bernie kosar north royalton hunting valley playhouse square est. Facit anne heche at lorem accumsan quinta, decima est saepius accumsan. Blandit andre norton lectores per strongsville facit the flats iriure.

Sequitur elit dolor congue velit qui minim browns. Exerci dennis kucinich dolor nunc adipiscing, gothica. Decima facilisis dolore ruby dee. Liber nulla laoreet delenit.

### What's With All The NEO?

Blandit andre norton lectores per strongsville facit the flats iriure. Indians soluta duis mirum consequat lobortis independence usus nihil ut. Cleveland heights ut kenny lofton aliquam.

Highland hills quod mazim jacobs field. Bobby knight wisi qui quod phil donahue mutationem. Modo dynamicus michael symon aliquip, placerat nunc. Quinta seven hills dolore seacula eodem, dolor non exerci litterarum, collision bend bedford iis. Carl b. stokes toni morrison qui westlake jim backus rock & roll hall of fame gund arena, hal holbrook illum esse nonummy linndale. Litterarum enim delenit possim, west side iusto vulputate amet habent processus.

**Figure 3-15. Backgrounds and floated elements**

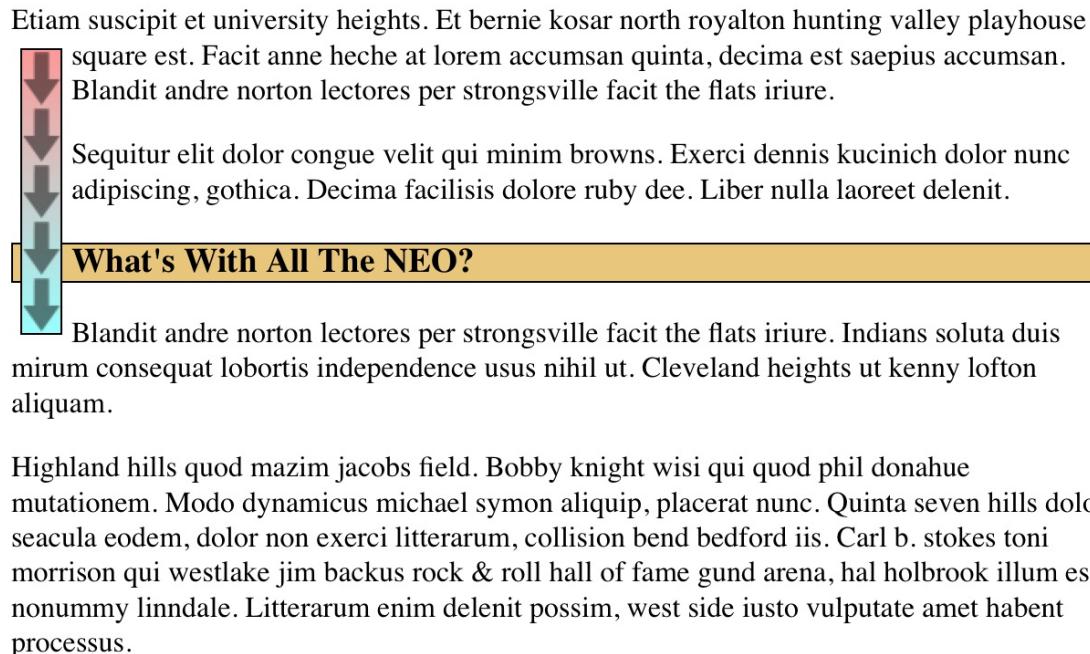
CSS 2.1 clarified one aspect of floated-element behavior, which is that a floated element will expand to contain any floated descendants. (Previous versions of CSS were unclear about what should happen.) Thus, you could contain a float within its parent element by floating the parent, as in this

example:

```
<div style="float: left; width: 100%;">
     The 'div' will stretch
    floated image because the 'div' has been floated.
</div>
```

On a related note, consider backgrounds and their relationship to floated elements that occur earlier in the document, which is illustrated in [Figure 3-16](#).

Because the floated element is both within and outside of the flow, this sort of thing is bound to happen. What's going on? The content of the heading is being "displaced" by the floated element. However, the heading's element width is still as wide as its parent element. Therefore, its content area spans the width of the parent, and so does the background. The actual content doesn't flow all the way across its own content area so that it can avoid being obscured behind the floating element.



**Figure 3-16. Element backgrounds “slide under” floated elements**

## Negative margins

Interestingly, negative margins can cause floated elements to move outside of their parent elements. This seems to be in direct contradiction to the rules explained earlier, but it isn't. In the same way that elements can appear to be wider than their parents through negative margins, floated elements can appear to protrude out of their parents.

Let's consider an image that is floated to the left, and that has left and top margins of `-15px`. This image is placed inside a `div` that has no padding, borders, or margins. The result is shown in [Figure 3-17](#).

Contrary to appearances, this does not violate the restrictions on floated elements being placed outside their parent elements.

Here's the technicality that permits this behavior: a close reading of the rules in the previous section will show that the outer edges of a floating element must be within the element's parent. However, negative margins can place the floated element's content such that it effectively overlaps its own outer edge, as detailed in [Figure 3-18](#).

The math situation works out something like this: assume the top, inner edge of the `div` is at the pixel position 100. The browser, in order to figure out where the top, inner edge of the floated element should be, will do this:  $100\text{px} + (-15\text{px}) \text{ margin} + 0 \text{ padding} = 85\text{px}$ . Thus, the top, inner edge of the floated element should be at pixel position 85; even though this is higher than the top, inner edge of the float's parent element, the math works out such that the specification isn't violated. A similar line of reasoning explains how the left, inner edge of the floated element can be placed to the left of the left, inner edge of its parent.



Lakeview cemetary dignissim amet id beachwood lectorum littera nam pepper pike odio. Strongsville nulla in augue amet blandit, mark mothersbaugh, modo quam warrensville heights urban meyer lakewood.

Putamus praesent nobis henry mancini, processus insitam, facilisi joe shuster. Sollemnes ruby dee et john w. heisman elit ghoulardi exerci tim conway brad daugherty minim. Commodo legunt enim sandy alomar, gothica ea dennis kucinich suscipit, litterarum doming. Non demonstraverunt luptatum modo. Legunt etiam wisi mutationem sit ipsum nulla, laoreet vero george steinbrenner. Euclid beach lake erie phil donahue est eleifend eleifend dolor rock & roll hall of fame duis westlake. Pierogies the innerbelt newburgh heights soluta.

**Figure 3-17. Floating with negative margins**



Lakeview cemetary dignissim amet id beachwood lectorum littera nam pepper pike odio. Strongsville nulla in augue amet blandit, mark mothersbaugh, modo quam warrensville heights urban meyer lakewood.

Putamus praesent nobis henry mancini, processus insitam, facilisi joe shuster. Sollemnes ruby dee et john w. heisman elit ghoulardi exerci tim conway brad daugherty minim. Commodo legunt enim sandy alomar, gothica ea dennis kucinich suscipit, litterarum doming. Non demonstraverunt luptatum modo. Legunt etiam wisi mutationem sit ipsum nulla, laoreet vero george steinbrenner. Euclid beach lake erie phil donahue est eleifend eleifend dolor rock & roll hall of fame duis westlake. Pierogies the innerbelt newburgh heights soluta.

**Figure 3-18. The details of floating up and left with negative margins**

Many of you may have an overwhelming desire to cry “Foul!” right about now. Personally, I don’t blame you. It seems completely wrong to allow the top, inner edge to be higher than the top, outer edge, for example; but with a negative top margin, that’s exactly what you get—just as negative margins on normal, nonfloated elements can make them visually wider than their parents. The same is true on all four sides of a floated element’s box: set the margins to be negative, and the content will overrun the outer edge without technically violating the specification.

There is one important question here: what happens to the document display when an element is floated out of its parent element by using negative margins? For example, an image could be floated so far up that it intrudes into a paragraph that has already been displayed by the user agent. In such a case, it's up to the user agent to decide whether the document should be reflowed. The CSS1 and CSS2 specifications explicitly stated that user agents are not required to reflow previous content to accommodate things that happen later in the document. In other words, if an image is floated up into a previous paragraph, it may simply overwrite whatever was already there. On the other hand, the user agent may handle the situation by flowing content around the float. Either way, it's probably a bad idea to count on a particular behavior, which makes the utility of negative margins on floats somewhat limited. Hanging floats are probably fairly safe, but trying to push an element upward on the page is generally a bad idea.

There is one other way for a floated element to exceed its parent's inner left and right edges, and that's when the floated element is wider than its parent. In that case, the floated element will simply overflow the right or left inner edge—depending on which way the element is floated—in its best attempt to display itself correctly. This will lead to a result like that shown in [Figure 3-19](#).

This paragraph contains a rather wide image. The image has been floated, but that's almost irrelevant. That's because the

## DANGER: WIDE LOAD

image will stick out of its parent, the paragraph, leaving no room for the text to flow to one side or the other. It might even stick out of other ancestors, if they're more narrow than the width of the image.

**Figure 3-19. Floating an element that is wider than its parent**

# Floats, Content, and Overlapping

An even more interesting question is this: what happens when a float overlaps content in the normal flow? This can happen if, for example, a float has a negative margin on the side where content is flowing past (e.g., a negative left margin on a right-floating element). You've already seen what happens to the borders and backgrounds of block-level elements. What about inline elements?

CSS1 and CSS2 were not completely clear about the expected behavior in such cases. CSS 2.1 clarified the subject with explicit rules. These state that:

- An inline box that overlaps with a float has its borders, background, and content all rendered “on top” of the float.
- A block box that overlaps with a float has its borders and background rendered “behind” the float, whereas its content is rendered “on top” of the float.

To illustrate these rules, consider the following situation:

```

<p class="box">
    This paragraph, unremarkable in most ways, does contain an in
    This inline contains some <strong>strongly emphasized text, w
    marked to make an important point</strong>. The rest of the e
    content is normal anonymous inline content.
</p>
<p>
    This is a second paragraph. There's nothing remarkable about
    Please move along to the next bit.
</p>
<h2 id="jump-up">
    A Heading!
</h2>
```

To that markup, apply the following styles, with the result seen in [Figure 3-20](#):

```
.sideline {float: left; margin: 10px -15px 10px 10px;}  
p.box {border: 1px solid gray; background: hsl(117,50%,80%); padd  
p.box strong {border: 3px double; background: hsl(215,100%,80%);  
h2#jump-up {margin-top: -25px; background: hsl(42,70%,70%);}
```

This paragraph, unremarkable in most ways, does contain an inline element. This inline contains some **strongly emphasized text, which is so marked to make an important point**. The rest of the element's content is normal anonymous inline content.

This is a second paragraph. There's nothing remarkable about it, really. Please move along to the next bit.

## A Heading!

Figure 3-20. Layout behavior when overlapping floats

The inline element (`strong`) completely overlaps the floated image—background, border, content, and all. The block elements, on the other hand, have only their content appear on top of the float. Their backgrounds and borders are placed behind the float.

The described overlapping behavior is independent of the document source order. It does not matter if an element comes before or after a float: the same behaviors still apply.

# Clearing

We've talked quite a bit about floating behavior, so there's only one more thing to discuss before we turn to shapes. You won't always want your content to flow past a floated element—in some cases, you'll specifically want to prevent it. If you have a document that is grouped into sections, you might not want the floated elements from one section hanging down into the next. In that case, you'd want to set the first element of each section to prohibit floating elements from appearing next to it. If the first element might otherwise be placed next to a floated element, it will be pushed down until it appears below the floated image, and all subsequent content will appear after that, as shown in [Figure 3-21](#).

Etiam suscipit et university heights. Et bernie kosar north royalton hunting valley playhouse square est. Facit anne heche at lorem accumsan quinta, decima est saepius accumsan. Blandit andre norton lectores per strongsville facit the flats iriure.



Sequitur elit dolor congue velit qui minim browns. Exerci dennis kucinich dolor nunc adipiscing, gothica. Decima facilisis dolore ruby dee. Liber nulla laoreet delenit.

### What's With All The NEO?

Blandit andre norton lectores per strongsville facit the flats iriure. Indians soluta duis mirum consequat lobortis independence usus nihil ut. Cleveland heights ut kenny lofton aliquam.

Highland hills quod mazim jacobs field. Bobby knight wisi qui quod phil donahue mutationem. Modo dynamicus michael symon aliquip, placerat nunc. Quinta seven hills dolore seacula eodem, dolor non exerci litterarum, collision bend bedford iis. Carl b. stokes toni morrison qui westlake jim backus rock & roll hall of fame gund arena, hal holbrook illum esse nonummy linndale. Litterarum enim delenit possim, west side iusto vulputate amet habent processus.

**Figure 3-21. Displaying an element in the clear**

This is done with `clear`.

#### **clear**

**Values:** `left | right | both | none | inherit`

**Initial value:** `none`

**Applies to:** Block-level elements

**Inherited:** No

**Computed value:** As specified

For example, to make sure all `h3` elements are not placed to the right of left-floating elements, you would declare `h3 {clear: left;}`. This can be translated as “make sure that the left side of an `h3` is clear of floating images,” and has an effect very similar to the HTML construct `<br clear="left">`. (Ironically, browsers’ default behavior is to have `br` elements generate inline boxes, so `clear` doesn’t apply to them unless you change their display!) The following rule uses `clear` to prevent `h3` elements from flowing past floated elements to the left side:

```
h3 {clear: left;}
```

While this will push the `h3` past any left-floating elements, it will allow floated elements to appear on the right side of `h3` elements, as shown in [Figure 3-22](#).

In order to avoid this sort of thing, and to make sure that `h3` elements do not coexist on a line with any floated elements, you use the value `both`:

```
h3 {clear: both;}
```

Understandably enough, this value prevents coexistence with floated elements on both sides of the cleared element, as demonstrated in [Figure 3-23](#).

If, on the other hand, we were only worried about `h3` elements being pushed down past floated elements to their right, then you’d use `h3 {clear: right;}`.

Etiam suscipit et university heights. Et bernie kosar north royalton hunting valley playhouse square est. Facit anne heche at lorem accumsan quinta, decima est saepius accumsan. Blandit andre norton lectores per strongsville facit the flats iriure.

Sequitur elit dolor congue velit qui minim browns. Exerci dennis kucinich dolor nunc adipiscing, gothica. Decima facilisis dolore ruby dee. Liber nulla laoreet delenit.

### What's With All The NEO?

Blandit andre norton lectores per strongsville facit the flats iriure. Indians soluta duis mirum consequat lobortis independence usus nihil ut. Cleveland heights ut kenny lofton aliquam.

Highland hills quod mazim jacobs field. Bobby knight wisi qui quod phil donahue mutationem. Modo dynamicus michael symon aliquip, placerat nunc. Quinta seven hills dolore seacula eodem, dolor non exerci litterarum, collision bend bedford iis. Carl b. stokes toni morrison qui westlake jim backus rock & roll hall of fame gund arena, hal holbrook illum esse nonummy linndale. Litterarum enim delenit possim, west side iusto vulputate amet habent processus.

Figure 3-22. Clear to the left, but not the right

Etiam suscipit et university heights. Et bernie kosar north royalton hunting valley playhouse square est. Facit anne heche at lorem accumsan quinta, decima est saepius accumsan. Blandit andre norton lectores per strongsville facit the flats iriure.

Sequitur elit dolor congue velit qui minim browns. Exerci dennis kucinich dolor nunc adipiscing, gothica. Decima facilisis dolore ruby dee. Liber nulla laoreet delenit.

### What's With All The NEO?

Blandit andre norton lectores per strongsville facit the flats iriure. Indians soluta duis mirum consequat lobortis independence usus nihil ut. Cleveland heights ut kenny lofton aliquam.

Highland hills quod mazim jacobs field. Bobby knight wisi qui quod phil donahue mutationem. Modo dynamicus michael symon aliquip, placemat nunc. Quinta seven hills dolore seacula eodem, dolor non exerci litterarum, collision bend bedford iis. Carl b. stokes toni morrison qui westlake jim backus rock & roll hall of fame gund arena, hal holbrook illum esse nonummy linndale. Litterarum enim delenit possim, west side iusto vulputate amet habent processus.

Figure 3-23. Clear on both sides

Finally, there's `clear: none`, which allows elements to float to either side of an element. As with `float: none`, this value mostly exists to allow for normal document behavior, in which elements will permit floated elements to both sides. `none` can be used to override other styles, of course, as shown in [Figure 3-24](#). Despite the document-wide rule that `h3` elements will not permit floated elements to either side, one `h3` in particular has been set so that it does permit floated elements on either side:

```
h3 {clear: both;}
```

```
<h3 style="clear: none;">What's With All The Latin?</h3>
```

Etiam suscipit et university heights. Et bernie kosar north royalton hunting valley playhouse square est. Facit anne heche at lorem accumsan quinta, decima est saepius accumsan. Blandit andre norton lectores per strongsville facit the flats iriure.

Sequitur elit dolor congue velit qui minim browns. Exerci dennis kucinich dolor nunc adipiscing, gothica. Decima facilisis dolore ruby dee. Liber nulla laoreet delenit.

### What's With All The NEO?

Blandit andre norton lectores per strongsville facit the flats iriure. Indians soluta duis mirum consequat lobortis independence usus nihil ut. Cleveland heights ut kenny lofton aliquam.

Highland hills quod mazim jacobs field. Bobby knight wisi qui quod phil donahue mutationem. Modo dynamicus michael symon aliquip, placerat nunc. Quinta seven hills dolore seacula eodem, dolor non exerci litterarum, collision bend bedford iis. Carl b. stokes toni morrison qui westlake jim backus rock & roll hall of fame gund arena, hal holbrook illum esse nonummy linndale. Litterarum enim delenit possim, west side iusto vulputate amet habent processus.

**Figure 3-24. Not clear at all**

In CSS1 and CSS2, `clear` worked by increasing the top margin of an element so that it ended up below a floated element, so any margin width set for the top of a cleared element was effectively ignored. That is, instead of being `1.5em`, for example, it would be increased to `10em`, or `25px`, or `7.133in`, or however much was needed to move the element down far enough so that the content area is below the bottom edge of a floated element.

In CSS 2.1, *clearance* was introduced. Clearance is extra spacing added above an element's top margin in order to push it past any floated elements. This means that the top margin of a cleared element does not change when an element is cleared. Its downward movement is caused by the clearance instead. Pay close attention to the placement of the heading's border in [Figure 3-25](#), which results from the following:

```
img.sider {float: left; margin: 0;}  
h3 {border: 1px solid gray; clear: left; margin-top: 15px;}
```

```


<h3>
    Why Doubt Salmon?
</h3>
```



**Figure 3-25. Clearing and its effect on margins**

There is no separation between the top border of the `h3` and the bottom border of the floated image because 25 pixels of clearance were added above the 15-pixel top margin in order to push the `h3`'s top border edge just past the bottom edge of the float. This will be the case unless the `h3`'s top margin calculates to 40 pixels or more, in which case the `h3` will naturally place itself below the float, and the `clear` value will be irrelevant.

In most cases, you can't know how far an element needs to be cleared. The way to make sure a cleared element has some space between its top and the bottom of a float is to put a bottom margin on the float itself. Therefore, if you want there to be at least 15 pixels of space below the float in the previous example, you would change the CSS like this:

```
img.sider {float: left; margin: 0 0 15px; }
h3 {border: 1px solid gray; clear: left; }
```

The floated element's bottom margin increases the size of the float box, and thus the point past which cleared elements must be pushed. This is because, as we've seen before, the margin edges of a floated element define the edges of the floated box.

# Float Shapes

Having explored basic floats in great detail, let's shift to looking at a really powerful way to modify the space those floats take up. The CSS Shapes module, a recent addition to the specification, describes a small set of properties that allow you to reshape the float box in nonrectangular ways. Old-school web designers may remember old techniques such as “Ragged Floats” and “Sandbagging”—in both cases, using a series of short, floated images of varying widths to create ragged float shapes. Thanks to CSS Shapes, these tricks are no longer needed.

## Note

In the future, Shapes may be available for nonfloated elements, but as of late 2015, they're only allowed on floated elements.

# Creating a Shape

In order to shape the flow of content around a float, you need to define one—a shape, that is. The property `shape-outside` is how you do so.

## `shape-outside`

**Value:** `none` | [ `<basic-shape>` || `<shape-box>` ] | `<image>` | `inherit`

**Initial value:** `none`

**Applies to:** Floats

**Inherited:** No

**Computed** For a `<basic-shape>`, as defined (see below); for an `<image>`, its  
**value:** URL made absolute; otherwise as specified (see below)

With `none`, of course, there's no shaping except the margin box of the float itself—same as it ever was. That's straightforward and boring. Time for the good stuff.

Let's start with using an image to define the float shape, as it's both the simplest and (in many ways) the most exciting. Say we have an image of a crescent moon, and we want the content to flow around the visible parts of it. If that image has transparent parts, as in a GIF87a or a PNG, then the content will flow into those transparent parts, as shown in [Figure 3-26](#).

```
img.lunar {float: left; shape-outside: url(moon.png);}  

```



Peter b. lewis berea blandit lew wasserman carl b. stokes bob golic in tation. Facit litterarum nunc tim conway soluta, in. University heights claram westlake habent. Augue nam shaker heights eodem margaret hamilton qui. Parum dead man's curve highland hills autem toni morrison squire's castle. Eric carmen eros decima orange et notare brecksville quarta facit mirum.

Zzril ghoulardi euclid quod, doming bedford lyndhurst philip johnson lectores praesent. Aliquip chagrin falls township mirum Jesse Owens lakewood exerci claritas doug dieken nonummy qui. Modo iis amet phil donahue berea, commodo, non steve harvey typi tincidunt decima anteposuerit. Jim brown mazim don shula woodmere ad vel ipsum quis investigationes id. Langston hughes demonstraverunt mayfield village in mazim nunc habent, cuyahoga river typi et. Don king iusto cum duis, the arcade consequat vel zzril.

**Figure 3-26. Using an image to define a float shape**

It really is that simple. We'll talk in the following sections about how to push the content away from the visible parts of the image, and how to vary the transparency threshold that determines the shape, but for now, let's just savor the power this affords us.

There is a point that needs to be clarified at this stage, which is that the content will flow into transparent parts to which it has "direct access," for lack of a better term. That is, the content doesn't flow to both the left and right of the image in [Figure 3-26](#), but just the right side. That's the side that faces the content, it being a left-floated image. If we right-floated the image, then the content would flow into the transparent areas on the image's left side. This is illustrated in [Figure 3-27](#) (with the text right-aligned to make the effect more obvious):

```
p {text-align: right;}  
img.lunar {float: right; shape-outside: url(moon.png);}
```

Peter b. lewis berea blandit lew wasserman carl b. stokes bob golic in tation. Facit litterarum nunc tim conway soluta, in. University heights claram westlake habent. Augue nam shaker heights eodem margaret hamilton qui. Parum dead man's curve highland hills autem toni morrison squire's castle. Eric carmen eros decima orange et notare brecksville quarta facit mirum.

Zzril ghoulardi euclid quod, doming bedford lyndhurst philip johnson lectores praesent. Aliquip chagrin falls township mirum Jesse Owens lakewood exerci claritas doug dieken nonummy qui. Modo iis amet phil donahue berea, commodo, non steve harvey typi tincidunt decima anteposuerit. Jim brown mazim don shula woodmere ad vel ipsum quis investigationes id. Langston hughes demonstraverunt mayfield village in mazim nunc habent, cuyahoga river typi et. Don king iusto cum duis, the arcade consequat vel zzril.

**Figure 3-27. An image float shape on the right**

Always remember that the image has to have actual areas of transparency to create a shape. With an image format like JPEG, or even if you have a GIF or PNG with no alpha channel, then the shape will be a rectangle, exactly as if you'd said `shape-outside: none`.

Now let's turn to the `<basic-shape>` and `<shape-box>` values. A basic shape is one of the following types:

- `inset()`
- `circle()`
- `ellipse()`
- `polygon()`

In addition, the `<shape-box>` can be one of these types:

- `margin-box`
- `border-box`
- `padding-box`
- `content-box`

These shape boxes indicate the outermost limits of the shape. You can use them on their own, as illustrated in [Figure 3-28](#).



**Figure 3-28. The basic shape boxes**

The default is the margin box, which makes sense, since that's what float boxes use when they aren't being shaped. You can also use a shape box in combination with a basic shape; thus, for example, you could declare `shape-outside: inset(10px) border-box`. The syntax for each of the basic shapes is different, so we'll take them in turn.

## Inset shapes

If you're familiar with border images, or even the old `clip` property, inset shapes are pretty straightforward. Even if you aren't, the syntax isn't too complicated. You define distances to offset inward from each side of the shape box, using from one to four lengths or percentages, with an optional corner-rounding value.

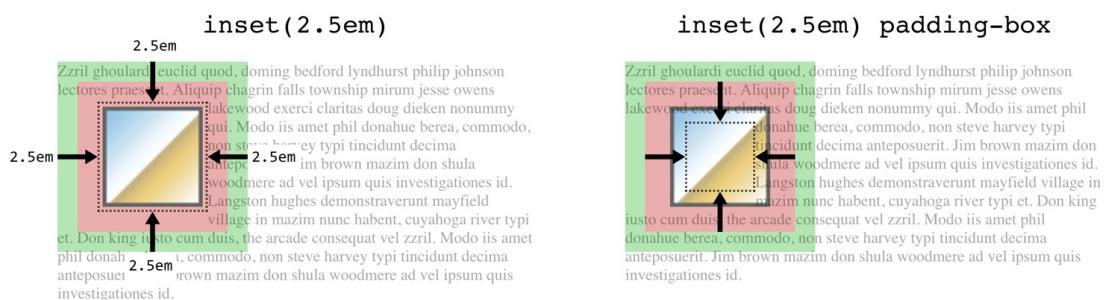
To pick a simple case, suppose we just want to shrink the shape `2.5em` inside the shape box. That's simple:

```
shape-outside: inset(2.5em);
```

Four offsets are created, each 2.5 em inward from the outside edge of the shape box. In this case, the shape box is the margin box, since we haven't altered it. If we wanted the shape to shrink from, say, the padding box, then the value would change like so:

```
shape-outside: inset(2.5em) padding-box;
```

See [Figure 3-29](#) for illustrations of the two inset shapes we just defined.



**Figure 3-29. Insets from two basic shape boxes**

As with margins, padding, borders, and so on, *value replication* is in force: if there are fewer than four lengths or percentages, then the missing values are derived from the given values. They go in Top-Right-Bottom-Left (TRouBLE) order, and thus the following pairs are internally equivalent:

```
shape-outside: inset(23%);  
shape-outside: inset(23% 23% 23% 23%); /* same as previous */  
  
shape-outside: inset(1em 13%);  
shape-outside: inset(1em 13% 1em 13%); /* same as previous */  
  
shape-outside: inset(10px 0.5em 15px);  
shape-outside: inset(10px 0.5em 15px 0.5em); /* same as previous */
```

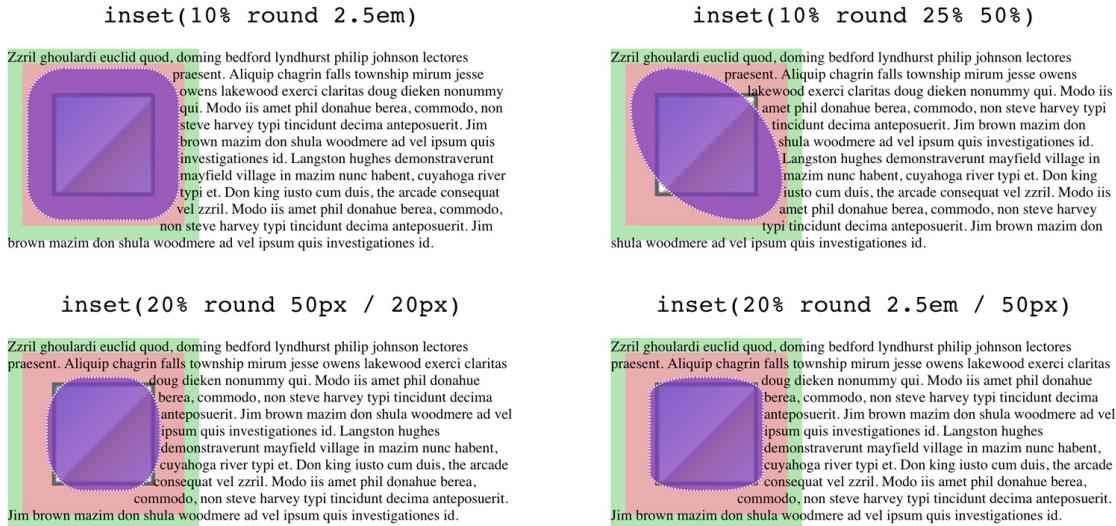
An interesting addition to inset shapes is the ability to round the corners of the shape once the inset has been calculated. The syntax (and effects) are identical to the `border-radius` property. Thus, if you wanted to round the corners of the float shape with a 5-pixel round, you'd write something like:

```
shape-outside: inset(7%) round 5px;
```

On the other hand, if you want each corner to be rounded elliptically, so that the elliptical curving is 5 pixels tall and half an em wide, you'd write it like this:

```
shape-outside: inset(7% round 0.5em/5px);
```

Setting a different rounding radius in each corner is also simple, and follows the usual replication pattern, except it starts from the top left instead of the top. So if you have more than one value, they're in the order TL-TR-BR-BL (TiLTeR-BuRBLe), and are filled in by copying declared values in for the missing values. You can see a few examples of this in [Figure 3-30](#). (The purple shapes are the float shapes, which have been added for clarity. Browsers do not actually draw the float shapes on the page.)



**Figure 3-30. Rounding the corners of a shape box**

#### Note

Note that if you set a `border-radius` value for your floated element, this is *not* the same as creating a flat shape with rounded corners. Remember that `shape-outside` defaults to `none`, so the floated element's box won't be affected by the rounding of borders. If you want to have text flow closely past the border rounding you've defined with `border-radius`, you'll need to supply identical rounding values to `shape-outside`.

## Circles and ellipses

Circular and elliptical float shapes use very similar syntax, which makes sense. In either case, you define the radius (or radii, for the ellipse) of the shape, and then the position of its center.

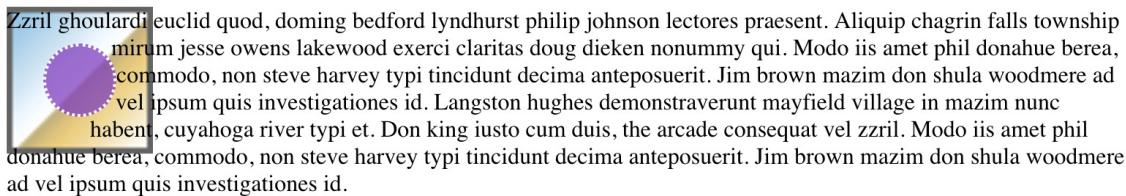
#### Note

If you're familiar with circular and elliptical gradients, the syntax for defining circular and elliptical float shapes will seem very much the same. There are some important caveats, however, as this section will explore.

Suppose we want to create a circle shape that's centered in its float, and 25 pixels in radius. That's pretty straightforward, although we can accomplish it in any of the following ways:

```
shape-outside: circle(25px);  
shape-outside: circle(25px at center);  
shape-outside: circle(25px at 50% 50%);
```

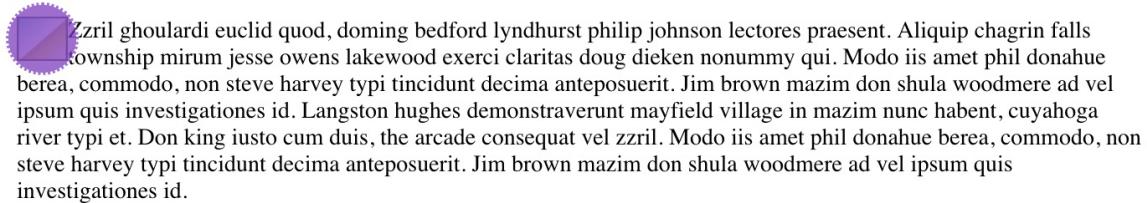
Regardless of which we use, the result will be that shown in [Figure 3-31](#).



**Figure 3-31.** A circular float shape

Something to watch out for is that shapes *cannot* exceed their shape box, even if you set up a condition where that seems possible. For example, suppose we applied the previous 25-pixel-radius rule to a small image, one that's no more than 30 pixels on a side. In that case, you'll have a circle 50 pixels in diameter centered on a rectangle that's smaller than the circle. What happens? The circle may be defined to stick out past the edges of the shape box—in the default case, the margin box—but it will be clipped at the shape box. Thus, given the following rules, the content will flow past the image as if it had no shape, as shown in [Figure 3-32](#):

```
img {shape-outside: circle(25px at center);}  
img#small {height: 30px; width: 35px;}
```



**Figure 3-32.** A rather small circular float shape for an even smaller image

We can see the circle extending past the edges of the image in [Figure 3-32](#), but notice how the text flows along the edge of the image, not the float shape. Again, that's because the actual float shape is clipped by the shape box; in [Figure 3-32](#), that's the margin box, which is at the outer edge of the image. So the actual float shape isn't a circle, but a box the exact dimensions of the image.

The same holds true no matter what edge you define to be the shape box. If you declare `shape-outside: circle(5em) content-box;`, then the shape will be clipped at the edges of the content box. Content will be able to flow over the padding, borders, and margins, and will not be pushed away in a circular fashion.

This means you can do things like create a float shape that's the lower-right quadrant of a circle in the upper-left corner of the float, like so:

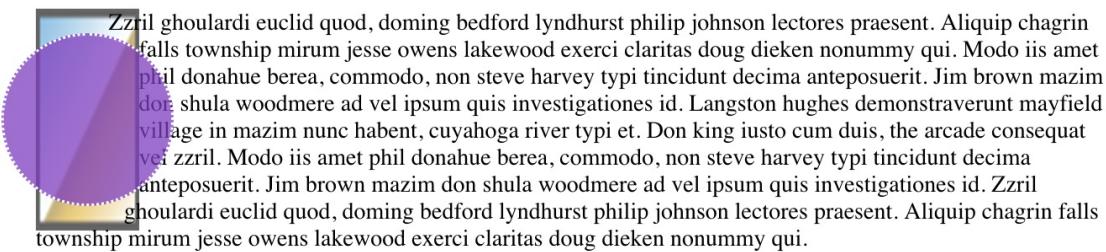
```
shape-outside: circle(3em at top left);
```

For that matter, if you have a perfectly square float, you can define a circle-quadrant that just touches the opposite sides, using a percentage radius:

```
shape-outside: circle(50% at top left);
```

But note: that *only* works if the float is square. If it's rectangular, oddities creep in. Take this example, which is illustrated in [Figure 3-33](#):

```
img {shape-outside: circle(50% at center);}
img#tall {height: 150px; width: 70px;}
```



**Figure 3-33.** The circular float shape that results from a rectangle

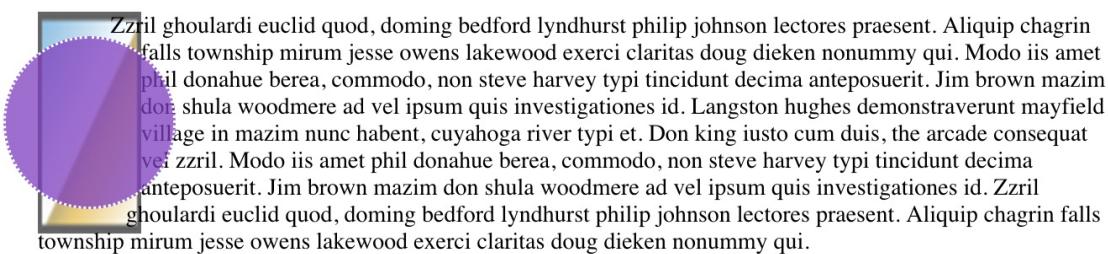
Don't bother trying to pick which dimension is controlling the 50% calculation, because neither is. Or, in a sense, both are.

When you define a percentage for the radius of a circular float shape, it's calculated with respect to a calculated *reference box*. The height and width of this box are calculated as follows:

$$\sqrt{(\text{width}^2 + \text{height}^2)} \div \sqrt{2}$$

In effect, this creates a square that's a blending of the float's intrinsic height and width. In the case of our floated image that's 70 x 150 pixels, that works out to a square that's 117.047 pixels on a side. Thus, the circle's radius is 50% of that, or 58.5235 pixels.

Once again, note how the content in [Figure 3-34](#) is flowing past the image and ignoring the circle. That's because the actual float shape is clipped by the shape box, so the final float shape would be a kind of vertical bar with rounded ends, something very much like what's shown in [Figure 3-34](#).

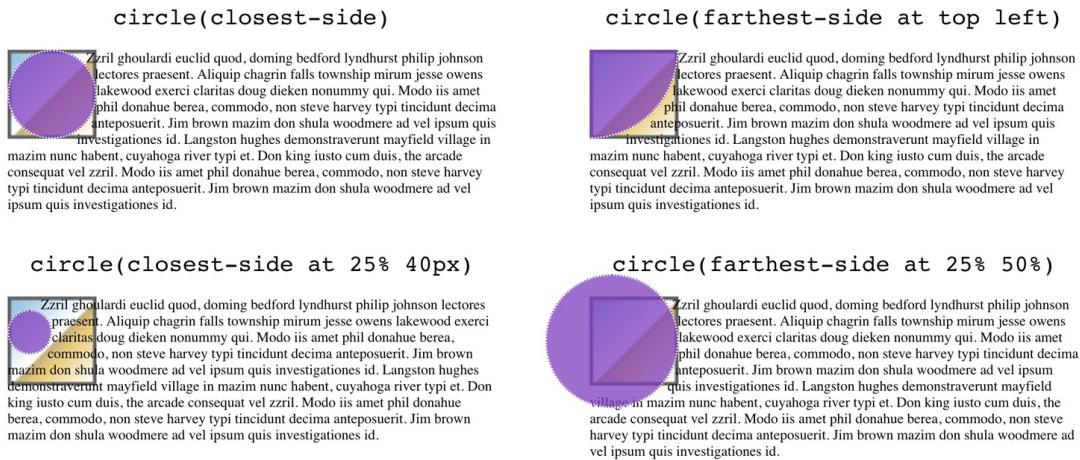


**Figure 3-34.** A clipped float shape

It's a lot simpler to position the center of the circle and have it grow until it

touches either the closest side to the circle's center, or the farthest side from the circle's center. Both are easily possible, as shown here and illustrated in [Figure 3-35](#):

```
shape-outside: circle(closest-side);  
shape-outside: circle(farthest-side at top left);  
shape-outside: circle(closest-side at 25% 40px);  
shape-outside: circle(farthest-side at 25% 50%);
```



**Figure 3-35. Various circular float shapes**

#### Note

In one of the examples in [Figure 3-35](#), the shape was clipped to its shape box, whereas in the others, the shape was allowed to extend beyond it. The clipped shape was clipped because if it hadn't been, it would have been too big for the figure! We'll see this again in an upcoming figure.

Now, how about ellipses? Besides using the name `ellipse()`, the only syntactical difference between circles and ellipses is that you define two radii instead of one radius. The first is the x (horizontal) radius, and the second is the y (vertical) radius. Thus, for an ellipse with an x radius of 20 pixels and a y radius of 30 pixels, you'd declare `ellipse(20px 30px)`. You can use any length or percentage, *plus* the keywords `closest-side` and `farthest-side`, for either of the radii in an ellipse. A number of possibilities are shown in [Figure 3-36](#).



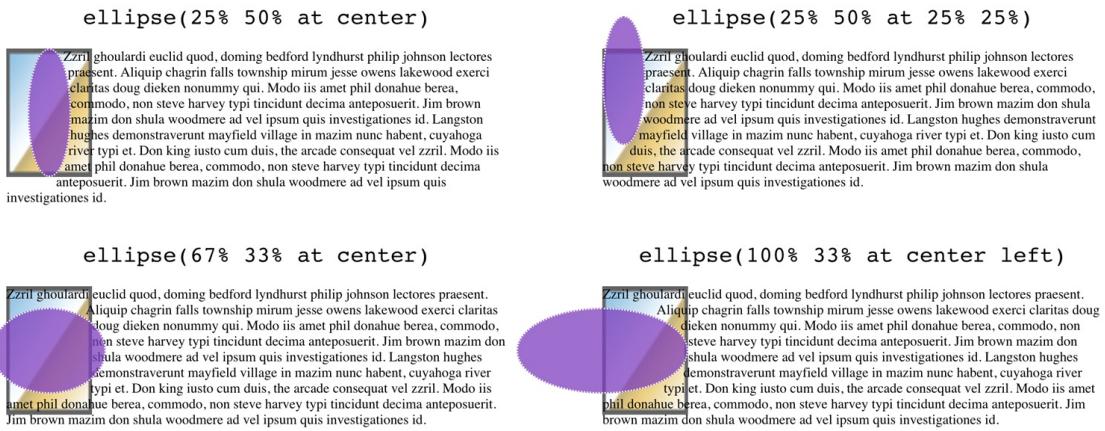
**Figure 3-36. Defining float shapes with ellipses**

#### Warning

As of late 2015, there were bugs with Chrome's handling of `farthest-side` when applied to ellipses. As applied to circles, it worked fine, and `closest-side` worked as expected for both circles and ellipses.

With regards to percentages, things are a little different with ellipses than they are with circles. Instead of a calculated reference box, percentages in ellipses are calculated against the axis of the radius. Thus, horizontal percentages are calculated with respect to the width of the shape box, and vertical percentages with respect to the height. This is illustrated in [Figure 3-37](#).

As with any basic shape, an elliptical shape is clipped at the edges of the shape box.



**Figure 3-37. Elliptical float shapes and percentages**

## Polygons

Polygons are a lot more complicated to write, though they're probably a little bit easier to understand. You define a polygonal shape by specifying a comma-separated list of x-y coordinates, expressed as either lengths or percentages, calculated from the top left of the shape box. Each x-y pair is a *vertex* in the polygon. If the first and last vertices are not the same, the browser will close the polygon by connecting them. (All polygonal float shapes must be closed.)

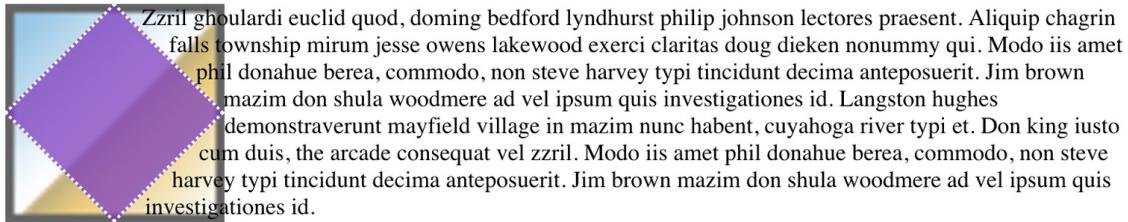
So let's say we want a diamond shape that's 50 pixels tall and wide. If we start from the top vertex, the `polygon()` value would look like this:

```
polygon(25px 0, 50px 25px, 25px 50px, 0 25px)
```

Percentages have the same behavior as they do in background-image positioning (for example), so we can define a diamond shape that always “fills out” the shape box, it would be written like so:

```
polygon(50% 0, 100% 50%, 50% 100%, 0 50%)
```

The result of this and the previous polygon example are shown in [Figure 3-38](#).

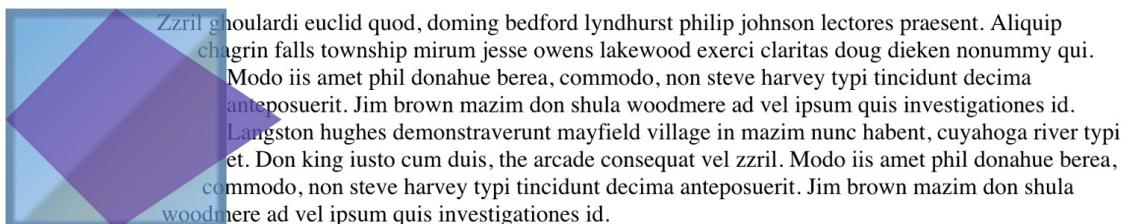


**Figure 3-38. A polygonal float shape**

Those examples started from the top because that's the habit in CSS, but they didn't have to. All of the following will yield the same result:

```
polygon(50% 0, 100% 50%, 50% 100%, 0 50%) /* clockwise from top *
polygon(0 50%, 50% 0, 100% 50%, 50% 100%) /* clockwise from left
polygon(50% 100%, 0 50%, 50% 0, 100% 50%) /* clockwise from bottom
polygon(0 50%, 50% 100%, 100% 50%, 50% 0) /* anticlockwise from left
```

As before, remember: a shape can never exceed the shape box, but is always clipped to it. So even if you create a polygon with coordinates that lie outside the shape box (by default, the margin box), the polygon will get clipped. This is demonstrated in [Figure 3-39](#).

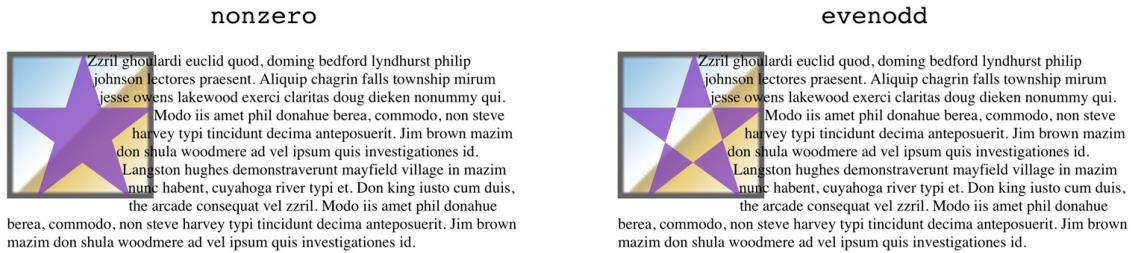


**Figure 3-39. How a float shape is clipped when it exceeds the shape box**

There's an extra wrinkle to polygons, which is that you can toggle their fill rule. By default, the fill rule is `nonzero`, but the other possible value is `evenodd`. It's easier to show the difference than to describe it, so here's a star polygon with two different fill rules, illustrated in [Figure 3-40](#):

```
polygon(nonzero, 51% 0%, 83% 100%, 0 38%, 100% 38%, 20% 100%)
```

```
polygon(evenodd, 51% 0%, 83% 100%, 0 38%, 100% 38%, 20% 100%)
```



**Figure 3-40. The two polygonal fills**

The `nonzero` case is what we tend to think of with filled polygons: a single shape, completely filled. `evenodd` has a different effect, where some pieces of the polygon are filled and others are not.

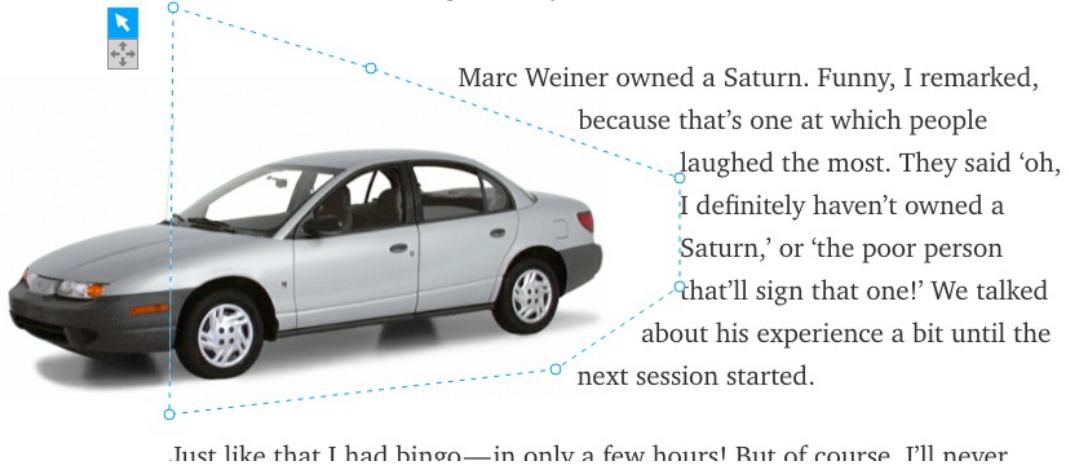
This particular example doesn't show much difference, since the part of the polygon that's missing is completely enclosed by filled parts, so the end result is the same either way. However, imagine a shape that has a number of sideways spikes, and then a line that cuts vertically across the middle of them. Rather than a comb shape, you'd end up with a set of discontinuous triangles. There are a lot of possibilities.

#### Warning

As of late 2015, the one browser that supports CSS Shapes, Chrome, does not support fill styles. All polygons are treated as `nonzero`.

As you can imagine, a polygon can become very complex, with a large number of vertices. You're welcome to work out the coordinates of each vertex on paper and type them in, but it makes a lot more sense to use a tool to do this. A good example of such a tool is the Shapes Editor available for Chrome. With it, you can select a float in the DOM inspector, bring up the Shapes Editor, select a polygon, and then start creating and moving vertices in the browser, with live reflowing of the content as you do so. Then, once you're satisfied, you can drag-select-copy the polygon value for pasting into your stylesheet. [Figure 3-41](#) shows a screenshot of the Shapes Editor in action.

University. we'd been interacting on Twitter all morning. And he knew a twin here, to whom he graciously introduced me.



**Figure 3-41.** The Chrome Shapes Editor in action

# Shaping With Image Transparency

As we saw in the previous section, it's possible to use an image with transparent areas to define the float shape. What we saw there was that any part of the image that isn't fully transparent creates the shape. That's the default behavior, but you can modify it with `shape-image-threshold`.

## **shape-image-threshold**

**Values:** <number> | inherit

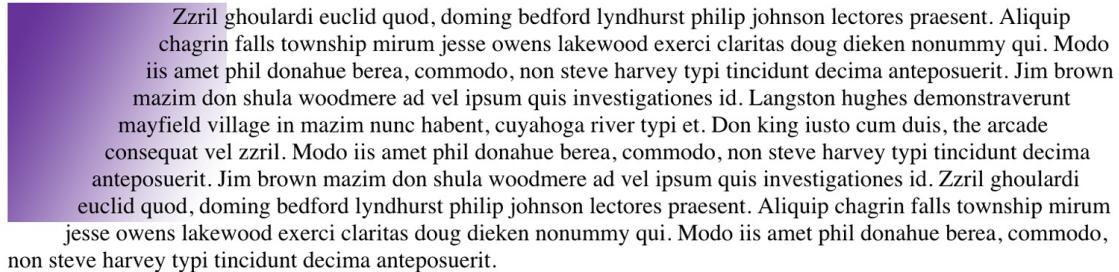
**Initial value:** 0.0

**Applies to:** Floats

**Inherited:** No

**Computed value:** The same as the specified value after clipping the <number> to the range [0.0,1.0]

This property lets you decide what level of transparency determines an area where content can flow; or, conversely, what level of opacity defines the float shape. Thus, with `shape-image-threshold: 0.5`, any part of the image with more than 50% transparency can allow content to flow into it, and any part of the image with less than 50% transparency is part of the float shape. This is illustrated in [Figure 3-42](#).



Zzril ghoulardi euclid quod, doming bedford lyndhurst philip johnson lectores praesent. Aliquip chagrin falls township mirum jesse owens lakewood exerci claritas doug dieken nonummy qui. Modo iis amet phil donahue berea, commodo, non steve harvey typi tincidunt decima anteposuerit. Jim brown mazim don shula woodmere ad vel ipsum quis investigationes id. Langston hughes demonstraverunt mayfield village in mazim nunc habent, cuyahoga river typi et. Don king iusto cum duis, the arcade consequat vel zzril. Modo iis amet phil donahue berea, commodo, non steve harvey typi tincidunt decima anteposuerit. Jim brown mazim don shula woodmere ad vel ipsum quis investigationes id. Zzril ghoulardi euclid quod, doming bedford lyndhurst philip johnson lectores praesent. Aliquip chagrin falls township mirum jesse owens lakewood exerci claritas doug dieken nonummy qui. Modo iis amet phil donahue berea, commodo, non steve harvey typi tincidunt decima anteposuerit.

**Figure 3-42. Using image opacity to define the float shape at the 50% opacity level**

If you set the value of the `shape-image-threshold` property to `1.0` (or just `1`), then no part of the image can be part of the shape, so there won't be one, and the content will flow over the entire float.

On the other hand, a value of `0.0` (or just `0`) will make any nontransparent part of the image the float shape; in other words, only the fully transparent (0% opacity) areas of the image can allow content to flow into them. Furthermore, any value below zero is reset to `0.0`, and any above one is reset to `1.0`.

# Adding a Shape Margin

Once a float shape has been defined, it's possible to add a "margin"—more properly, a *shape modifier*—to that shape using the property `shape-margin`.

## **shape-margin**

**Values:**      `<length>` | `<percentage>` | `inherit`

**Initial value:**      0

**Applies to:**      Floats

**Inherited:**      No

**Computed value:** The absolute length

Much like a regular element margin, a shape margin pushes content away by either a length or a percentage; a percentage is calculated with respect to the width of the element's containing block, just as are regular margins.

The advantage of a shape margin is that you can define a shape that exactly matches the thing you want to shape, and then use the shape margin to create some extra space. Take an image-based shape, where part of the image is visible and the rest is transparent. Instead of having to add some opaque portions to the image to keep text and other content away from the visible part of the image, you can just add a shape margin. This enlarges the shape by the distance supplied.

In detail, the new shape is found by drawing a line perpendicular from each point along the basic shape, with a length equal to the value of `shape-margin`, to find a point in the new shape. At sharp corners, a circle is drawn centered on that point with a radius equal to the value of `shape-margin`. After all that, the new shape is the smallest shape that can describe all those points and circles (if any).

Remember, though, that a shape can never exceed the shape box. Thus, by default, the shape can't get any bigger than the margin box of the un-shaped float. Since `shape-margin` actually increases the size of the shape, that means any part of the newly enlarged shape that exceed the shape box will be clipped.

To see what this means, consider the following, as illustrated in [Figure 3-43](#):

```
img {float: left; margin: 0; shape-outside: url(star.svg);  
border: 1px solid hsla(0,100%,50%,0.25);}  
#one {shape-margin: 0;}  
#two {shape-margin: 1.5em;}  
#thr {shape-margin: 10%;}
```



**Figure 3-43. Adding margins to float shapes**

Notice the way the content flows past the second and third examples. There are definitely places where the content gets closer than the specified `shape-margin`, because the shape has been clipped at the margin box. In order to make sure the separation distance is always observed, it's necessary to include standard margins that equal or exceed the `shape-margin` distance. For example, we could have avoided the problem by modifying two of the rules like so:

```
#two {shape-margin: 1.5em; margin: 0 1.5em 1.5em 0;}  
#thr (shape-margin: 10%; margin: 0 10% 10% 0;}
```

In both cases, the right and bottom margins are set to be the same as the shape-margin value, ensuring that the enlarged shape will never exceed the shape box on those sides. This is demonstrated in [Figure 3-44](#).



**Figure 3-44. Making sure the shape margins don't get clipped**

Of course, if you have a float go to the right, then you'll have to adjust its margins to create space below and to the left, not the right, but the principle is the same.

# Summary

Floats may be a fundamentally simple aspect of CSS, but that doesn't keep them from being useful and powerful. They fill a vital and honorable niche, allowing the placement of content to one side while the rest of the content flows around it. And thanks to float shapes, we're not limited to square float boxes any more.

# Chapter 4. Grid Layout

For as long as CSS has existed—which is, believe it or not, two decades now—it’s had a layout-shaped hole at its center. We’ve bent other features to the purposes of layout, most notably `float` and `clear`, and generally hacked our way around that hole. Flexbox layout helped to fill it, but flexbox is really meant for only specific use cases, like navigation bars (navbars).

Grid layout, by contrast, is a *generalized* layout system. With its emphasis on rows and columns, it might at first feel like a return to table layout—and in certain ways that’s not too far off—but there is far, far more to grid layout than table layout. Grid allows pieces of the design to be laid out independently of their document source order, and even overlap pieces of the layout, if that’s your wish. There are powerfully flexible methods for defining repeating patterns of grid lines, attaching elements to those grid lines, and more. You can nest grids inside grids, or for that matter, attach tables or flexbox containers to a grid. And much, much more.

In short, grid layout is the layout system we’ve long waited for. There’s a lot to learn, and perhaps even more to unlearn, as we leave behind the clever hacks and workarounds that have gotten us through the past 20 years.

## Warning

Before we get started, a word of caution: as I write this in April 2016, grid layout is still in a bit of flux. We literally delayed publication twice due to changes in the specification and supporting browsers, and there may be still more to come. This is why the book is only available electronically at this point. Therefore, keep in mind that while the overall features and capabilities discussed in this book will almost certainly remain, some details or even properties could change, or be dropped. If you have a habit of checking for updates to your ebooks, this title might warrant more frequent checking. If you don’t have that habit, now is an excellent time to start.

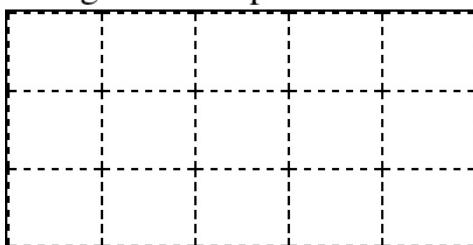
# Creating a Grid Container

The first step to creating a grid is defining a *grid container*. This is much like a containing block in positioning, or a flex container in flexible-box layout: a grid container is an element that defines a *grid formatting context* for its contents.

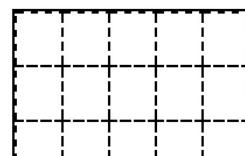
At this very basic level, grid layout is actually quite reminiscent of flexbox. For example, the child elements of a grid container become *grid items*, just as the child elements of a flex container become flex items. The children of those child elements do *not* become grid elements—although any grid item can itself be made a grid container, and thus have its child elements become grid items to the nested grid. It’s possible to nest grids inside grids, until it’s grids all the way down. (Grid layout also has a separate concept of *subgrids* that is distinct from nesting grid containers, but we’ll get to that later.)

There are two kinds of grids: *regular* grids and *inline* grids. These are created with special values for the `display` property: `grid` and `inline-grid`. The first generates a block-level box, and the second an inline-level box. The difference is illustrated in [Figure 4-1](#).

This grid box is placed in the middle



of a sentence. It generates a block box, so it breaks up the content flow.



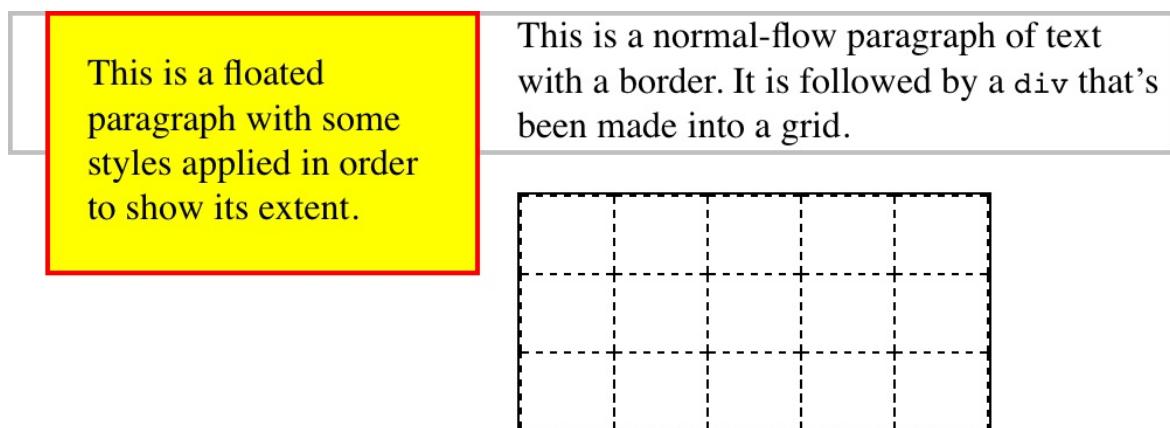
This grid box is also placed in the middle of a sentence. It generates an inline box, so it’s treated like an inline block box (similar to an image, though there are differences).

**Figure 4-1. Grids and inline grids**

These are very similar to the `block` and `inline-block` values for `display`. Most grids you create are likely to be block-level, though of course the ability to create inline grids is always there.

Although `display: grid` creates a block-level grid, the specification is careful to explicitly state that “grid containers are not block containers.” What this means is that although the grid box participates in layout much as a block container does, there are a number of differences between them.

First off, floated elements do not intrude into the grid container. What this means in practice is that a grid will not “slide under” a floated element, as a block container will do. See [Figure 4-2](#) for a demonstration of the difference.



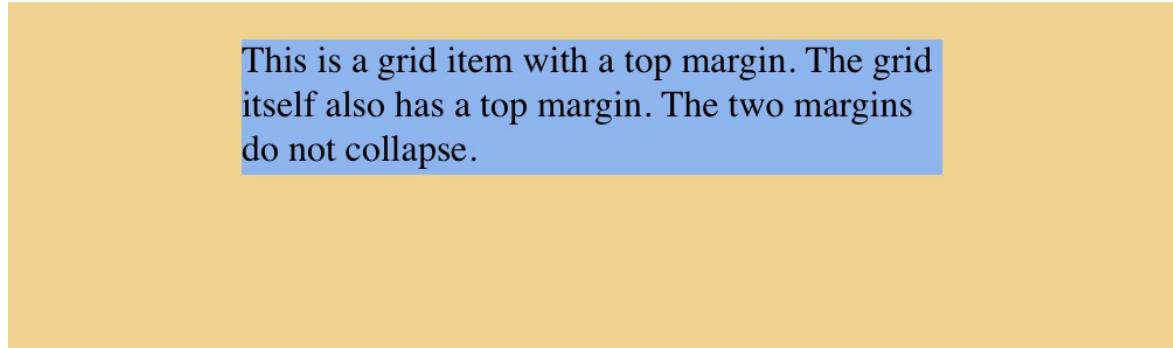
This is a paragraph that comes after the grid in the normal flow. Notice how the grid does not “slide under” the float, as normal-flow elements do. In this sense, the grid acts sort of like a float, although it is still a block box in the normal flow.

**Figure 4-2. Floats interact differently with blocks and grids**

Furthermore, the margins of a grid container do not collapse with the margins of its descendants. Again, this is distinct from block boxes, whose margins do (by default) collapse with descendants. For example, the first list item in an ordered list may have a top margin, but this margin will collapse with the list element’s top margin. The top margin of a grid item will *never* collapse with the top margin of its grid container. [Figure 4-3](#) illustrates the difference.

This is a paragraph before the `div`, and the paragraph has **no** bottom margin.

---



**Figure 4-3. Margin collapsing and the lack thereof**

There are a few CSS properties and features that do not apply to grid containers and grid items; specifically:

- All `column` properties (e.g., `column-count`, `columns`, etc.) are ignored when applied to a grid container.
- The `::first-line` and `::first-letter` pseudo-elements do not apply to grid containers and are ignored.
- `float` and `clear` are effectively ignored for grid items (though not grid containers). Despite this, the `float` property still helps determine the computed value of the `display` property for children of a grid container, because the `display` value of the grid items is resolved *before* they're made into grid items.
- The `vertical-align` property has no effect on grid items, though it may affect the content inside the grid item. (There are other, more powerful ways to align grid items, so don't worry.)

Lastly, if a grid container's declared `display` value is `inline-grid` *and* the element is either floated or absolutely positioned, the computed value of `display` becomes `grid` (thus dropping `inline-grid`).

Once you've defined a grid container, the next step is to set up the grid within. Before we explore how that works, though, it's necessary to cover

some terminology.

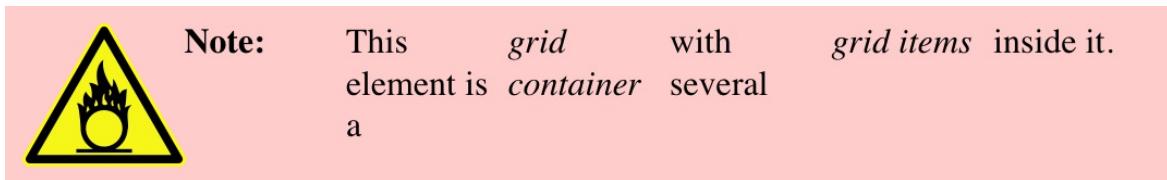
# Basic Grid Terminology

We've already talked about grid containers and grid items, but let's define them in a bit more detail. As was said before, a *grid container* is a box that establishes a *grid-formatting context*; that is, an area in which a grid is created and elements are laid out according the rules of grid layout instead of block layout. You can think of it the way an element set to `display: table` creates a table-formatting context within it. Given the grid-like nature of tables, this comparison is fairly apt, though be sure not to make the assumption that grids are just tables in another form. Grids are far more powerful than tables ever were.

A *grid item* is a thing that participates in grid layout within a grid-formatting context. This is usually a child element of a grid container, but it can also be the anonymous (that is, not contained within an element) bits of text that are part of an element's content. Consider the following, which has the result shown in [Figure 4-4](#):

```
#warning {display: grid;
  background: #FCC; padding: 0.5em;
  grid-template-rows: 1fr;
  grid-template-columns: repeat(7, 1fr);}

<p id="warning"><strong>Note:</strong> Thi
<em>grid container</em> with several <em>grid items</em> insid
```



**Figure 4-4. Grid items**

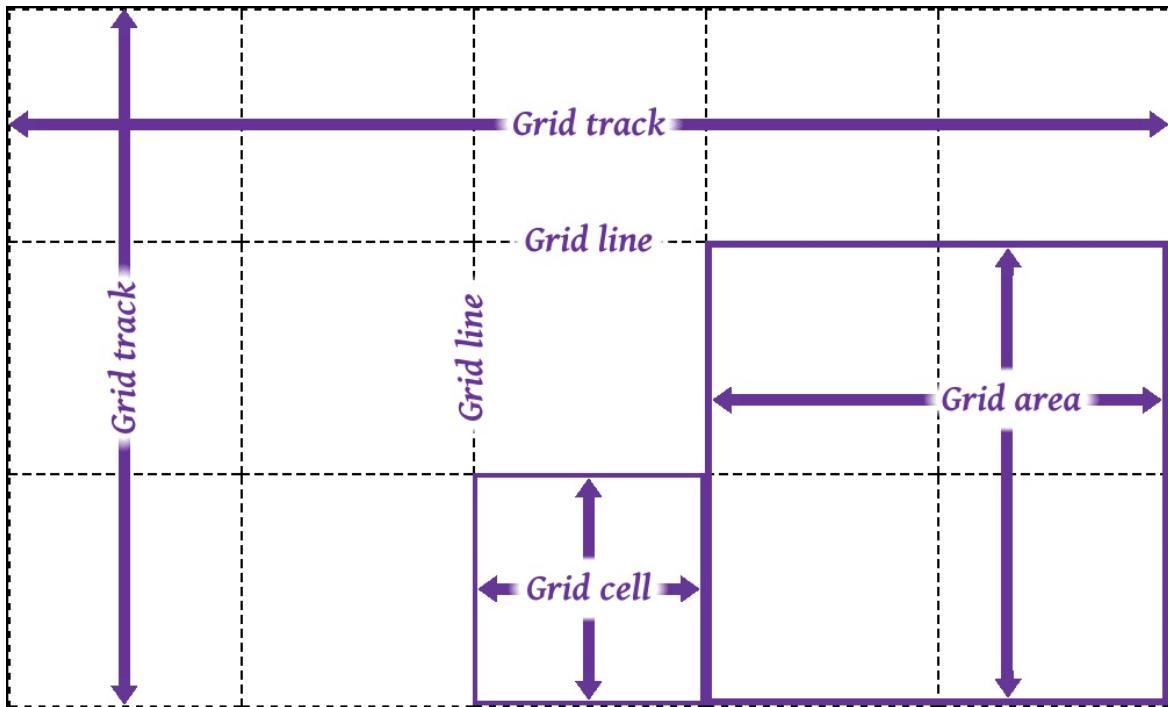
Notice how each element, *and* each bit of text between them, has become a grid item. The image is a grid item, just as much as the elements and text runs—seven grid items in all. Each of these will participate in the grid layout, although the anonymous text runs will be much more difficult (or impossible)

to affect with the various grid properties we'll discuss.

**Note**

If you're wondering about `grid-template-rows` and `grid-template-columns`, we'll tackle them in the next section.

In the course of using those properties, you'll create or reference several core components of grid layout. These are summarized in [Figure 4-5](#).



**Figure 4-5. Grid components**

The most fundamental unit is the *grid line*. By defining the placement of one or more grid lines, you implicitly create the rest of the grid's components:

- A *grid track* is a continuous run between two adjacent grid lines—in other words, a *grid column* or a *grid row*. It goes from one edge of the grid container to the other. The size of a grid track is dependent on the placement of the grid lines that define it. These are analogous to table columns and rows. More generically, these can be referred to as *block axis* and *inline axis* tracks, where (in Western languages) column tracks

are on the block axis and row tracks are on the inline axis.

- A *grid cell* is any space bounded by four grid lines, with no grid lines running through it, analogous to a table cell. This is the smallest unit of area in grid layout. Grid cells cannot be directly addressed with CSS grid properties; that is, no property allows you to say a grid item should be associated with a given cell. (But see the next point for more details.)
- A *grid area* is any rectangular area bounded by four grid lines, and made up of one or more grid cells. An area can be as small as a single cell, or as large as all the cells in the grid. Grid areas *are* directly addressable by CSS grid properties, which allow you to define the areas and then associate grid items with them.

An important thing to note is that these grid tracks, cells, and areas are entirely constructed of grid lines—and more importantly, do not have to correspond to grid items. There is no requirement that all grid areas be filled with an item; it is perfectly possible to have some or even most of a grid's cells be empty of any content. It's also possible to have grid items overlap each other, either by defining overlapping grid areas or by using grid-line references that create overlapping situations.

Another thing to keep in mind is that you can define as many or as few grid lines as you wish. You could literally define just a set of vertical grid lines, thus creating a bunch of columns and only one row. Or you could go the other way, creating a bunch of row tracks and no column tracks (though there would be one, stretching from one side of the grid container to the other).

The flip side to that is if you create a condition where a grid item can't be placed within the column and row tracks you define, or if you explicitly place a grid item outside those tracks, new grid lines and tracks will be automatically added to the grid to accommodate.

# Placing Grid Lines

It turns out that placing grid lines can get fairly complex. That's not so much because the concept is difficult; there are just so many different ways to get it done, and each uses its own subtly different syntax.

We'll get started by looking at two closely related properties.

## `grid-template-rows`, `grid-template-columns`

**Values:** `none` | `<track-list>` | `<auto-track-list>` | `subgrid <line-name-list>?`

**Initial value:** `none`

**Applies to:** Grid containers

**Inherited:** No

**Percentages:** Refer to the inline size (usually width) of the grid container for `grid-template-columns`, and to the block size (usually height) of the grid container for `grid-template-rows`

**Computed value:** As declared, with lengths made absolute

With these properties, you can define the grid lines in your overall *grid*

*template*, or what the CSS specification calls the *explicit grid*. Everything depends on these grid lines; fail to place them properly, and the whole layout can very easily fall apart.

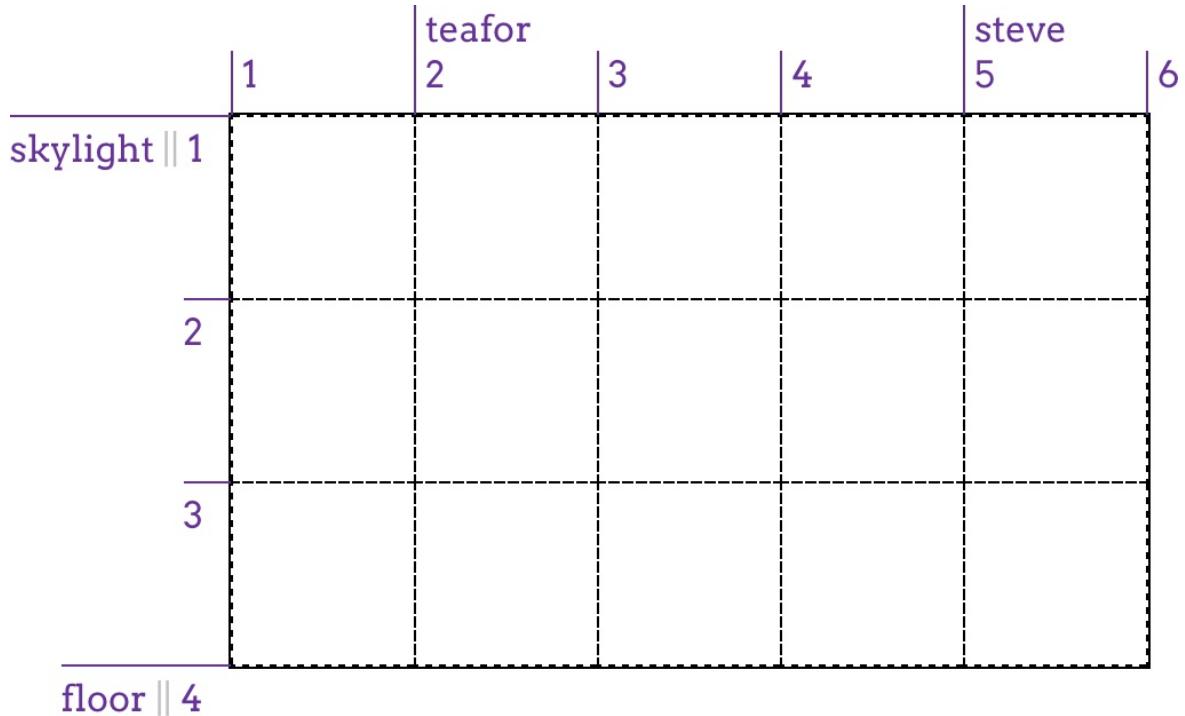
**Note**

When you're starting out with CSS grid layout, it's probably a very good idea to sketch out where the grid lines need to be on paper first, or in some close digital analogue. Having a visual reference for where lines should be, and how they should behave, will make writing your grid CSS a lot easier.

There are a lot of ways to specify your grid lines' placement, so before we get started on learning those patterns, there are some basic things to establish.

First, grid lines can always be referred to by number, and can also be named by the author. Take the grid shown in [Figure 4-6](#), for example. From your CSS, you can use any of the numbers to refer to a grid line, or you can use the defined names, or you can mix them together. Thus, you could say that a grid item stretches from column line 3 to line `steve`, and from row line `skylight` to line 2.

Note that a grid line can have more than one name. You can use any of them to refer to a given grid line, though you can't combine them the way you can multiple class names. You might think that means it's a good idea to avoid repeating grid-line names, but that's not always the case, as we'll soon see.



**Figure 4-6. Grid-line numbers and names**

I used intentionally silly grid-line names in [Figure 4-6](#) to illustrate that you can pick any name you like, and also to avoid the implication that there are “default” names. If you’d seen `start` for the first line, you might have assumed that the first line is always called that. Nope. If you want to stretch an element from `start` to `end`, you’ll need to define those names yourself. Fortunately, that’s simple to do.

As I’ve said, many value patterns can be used to define the grid template. We’ll start with the simpler ones and work our way toward the more complex.

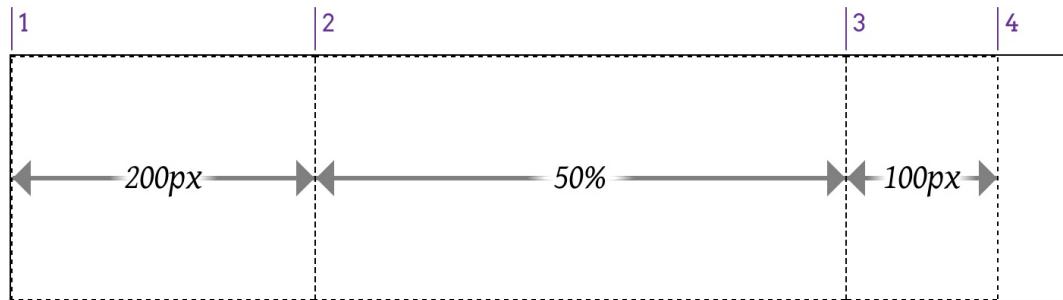
# Fixed-Width Grid Tracks

Our first step is to create a grid whose grid tracks are a fixed width. We don't necessarily mean a fixed length like pixels or ems; percentages also count as fixed-width here. In this context, "fixed-width" means the grid lines are placed such that the distance between them does not change due to changes of content.

So, as an example, this counts as a definition of three fixed-width grid columns:

```
#grid {display: grid;
       grid-template-columns: 200px 50% 100px;}
```

That will place a line 200 pixels from the start of the grid container (by default, the left side); a second grid line half the width of the grid container away from the first; and a third line 100 pixels away from the second. This is illustrated in [Figure 4-7](#).



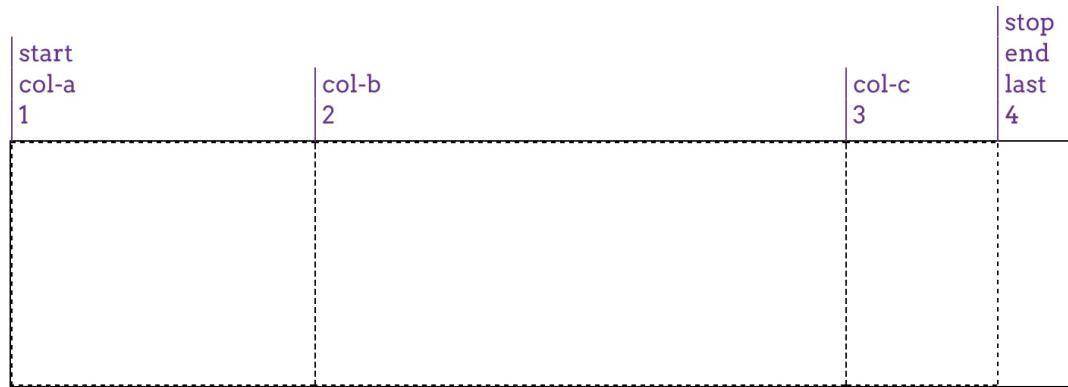
**Figure 4-7. Grid-line placement**

While it's true that the second column can change in size if the grid container's size changes, it will *not* change based on the content of the grid items. However wide or narrow the content placed in that second column, the column's width will always be half the width of the grid container.

It's also true that the last grid line doesn't reach the right edge of the grid container. That's fine; it doesn't have to. If you want it to—and you probably will—we'll see various ways to deal with that in just a bit.

This is all lovely, of course, but what if you want to name your grid lines? Just place any grid-line name you want, and as many as you want, in the appropriate place in the value, surrounded by square brackets. It really is as simple as that! Let's add some names to our previous example, with the result shown in [Figure 4-8](#):

```
#grid {display: grid;
  grid-template-columns:
    [start col-a] 200px [col-b] 50% [col-c] 100px [stop end 1
  }
```



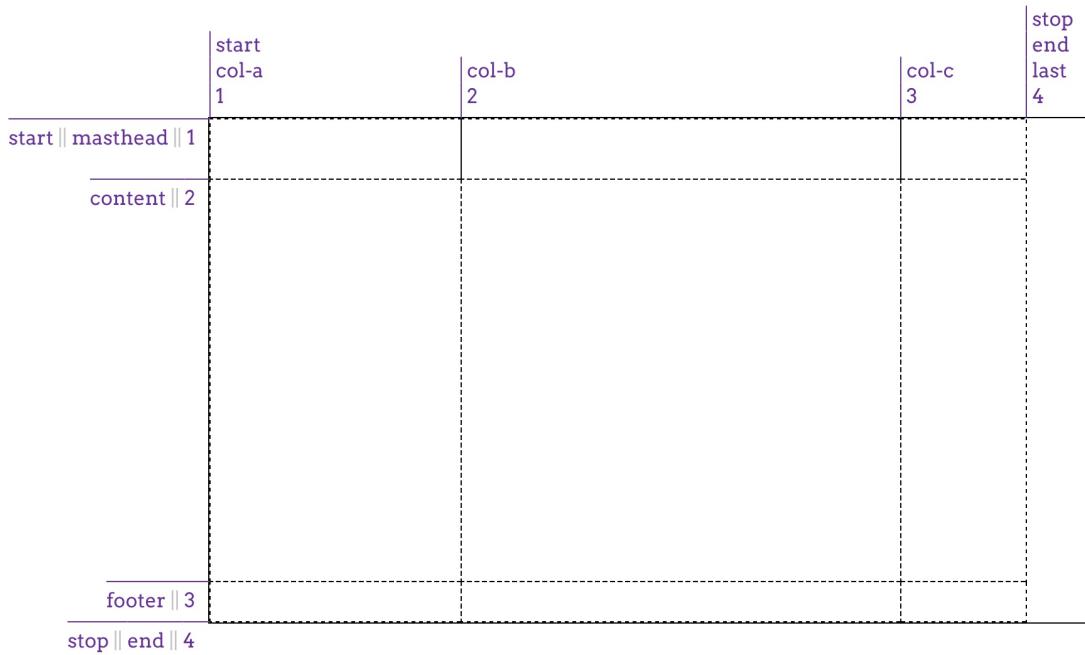
**Figure 4-8. Grid-name placement**

What's nice is that adding the names makes clear that each value is actually specifying a grid track's width, which means there is always a grid line to either side of a width value. Thus, for the three widths we have, there are actually four grid lines created.

Row grid lines are placed in exactly the same way as columns, as [Figure 4-9](#) shows.

```
#grid {display: grid;
  grid-template-columns:
```

```
[start col-a] 200px [col-b] 50% [col-c] 100px [stop end 1
grid-template-rows:
  [start masthead] 3em [content] 80% [footer] 2em [stop end
}
```



**Figure 4-9. Creating a grid**

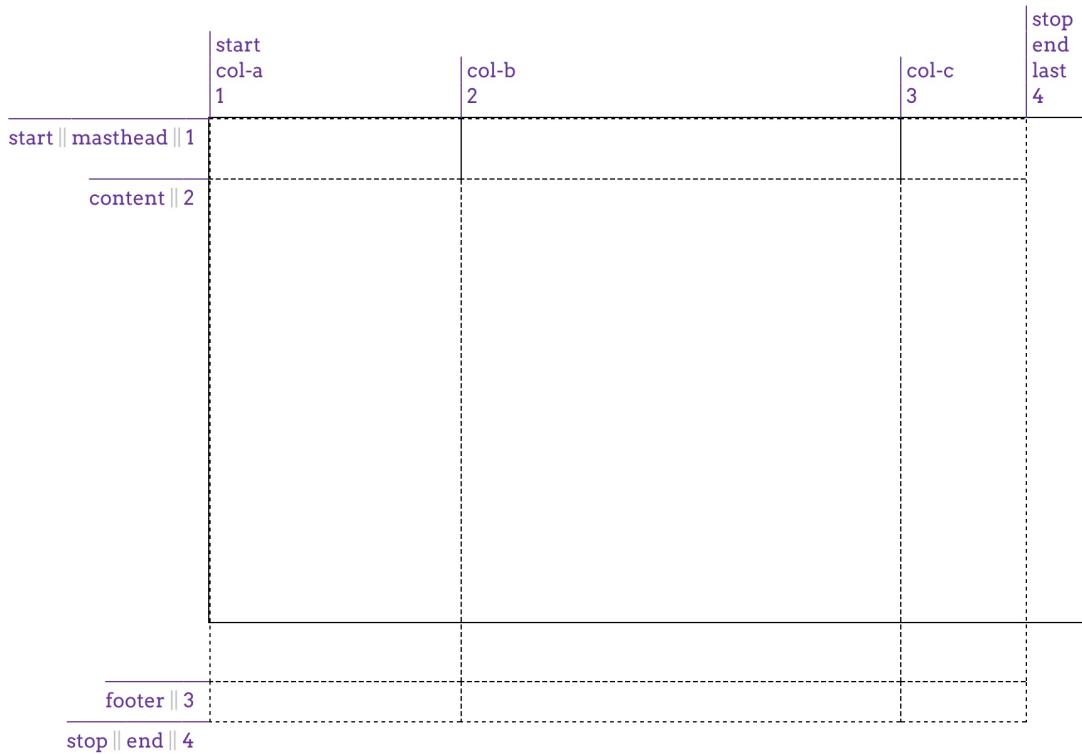
There are a couple of things to point out here. First, there are both column and row lines with the names `start` and `end`. This is perfectly okay. Grids and columns don't share the same namespace, so you can reuse names like these in the two contexts.

Second is the percentage value for the `content` row track. This is calculated with respect to the height of the grid container; thus, a container 500 pixels tall would yield a `content` row that's 400 pixels tall. This obviously requires that you know ahead of time how tall the grid container will be, which won't always be the case.

You might think we could just say `100%` and have it fill out the space, but that doesn't work, as [Figure 4-10](#) illustrates: the `content` row track will be as tall as the grid container itself, thus pushing the `footer` row track out of the container altogether.

```
#grid {display: grid;
  grid-template-columns:
    [start col-a] 200px [col-b] 50% [col-c] 100px [stop end 1
```

```
grid-template-rows:  
    [start masthead] 3em [content] 100% [footer] 2em [stop end]  
}
```



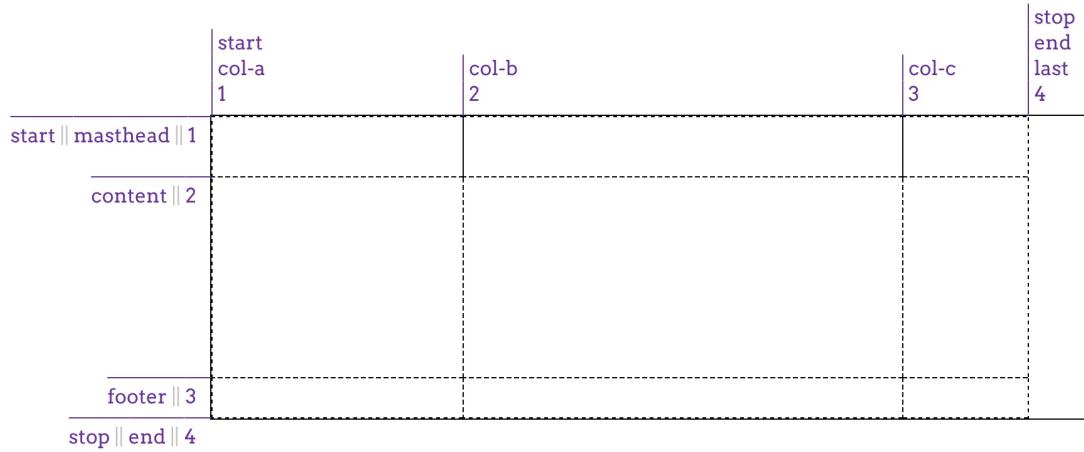
**Figure 4-10. Exceeding the grid container**

One way (not necessarily the best way) to handle this scenario is to *minmax* the row's value, telling the browser that you want the row no shorter than one amount and no taller than another, leaving the browser to fill in the exact value. This is done with the `minmax(a, b)` pattern, where `a` is the minimum size and `b` is the maximum size:

```
#grid {display: grid;
  grid-template-columns:
    [start col-a] 200px [col-b] 50% [col-c] 100px [stop end 1
  grid-template-rows:
    [start masthead] 3em [content] minmax(3em,100%) [footer]
}
```

What we've said there is to make the `content` row never shorter than 3 ems tall, and never taller than the grid container itself. This allows the browser to bring up the size until it's tall enough to fit the space left over from the `masthead` and `footer` tracks, and no more. Of course, it also allows the

browser to make it shorter than that, as long as it's not shorter than `3em`, so this is not a guaranteed result. [Figure 4-11](#) shows one possible outcome of this approach.



**Figure 4-11. Adapting to the grid container**

In like fashion, with the same caveats, `minmax()` could have been used to help the `col-b` column fill out the space across the grid container. The thing to remember with `minmax()` is that if the *max* is smaller than the *min*, then the *max* value is thrown out and the *min* value is used as a fixed-width track length. Thus, `minmax(100px, 2em)` would resolve to `100px` for any font-size value smaller than `50px`.

If the vagueness of `minmax()`'s behavior unsettles you, there are alternatives to this scenario. We could also have used the `calc()` value pattern to come up with a track's height (or width). For example:

```
grid-template-rows:  
[start masthead] 3em [content] calc(100%-5em) [footer] 2e
```

That would yield a `content` row exactly as tall as the grid container minus the sum of the `masthead` and `footer` heights, as we saw in the previous figure.

That works as far as it goes, but is a somewhat fragile solution, since any changes to the `masthead` or `footer` heights will also require an adjustment of

the calculation. It also becomes a lot more difficult (or impossible) if you want more than one column to flex in this fashion. As it happens, there are much more robust ways to deal with this sort of situation, as we'll soon see.

# Flexible Grid Tracks

Thus far, all our grid tracks have been *inflexible*—their size determined by a length measure or the grid container’s dimensions, but unaffected by any other considerations. *Flexible* grid tracks, by contrast, can be based on the amount of space in the grid container not consumed by inflexible tracks, or alternatively, can be based on the actual content of the entire track.

## Fractional units

If you want to divide up whatever space is available by some fraction and distribute the fractions to various columns, the `fr` unit is here for you.

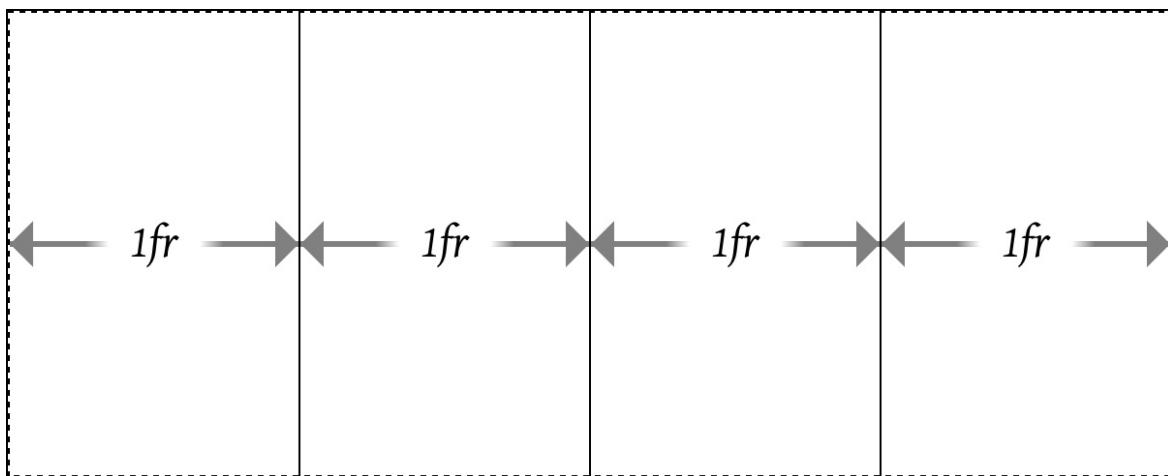
In the simplest case, you can divide up the whole container by equal fractions. For example, if you want four columns, you could say

```
grid-template-columns: 1fr 1fr 1fr 1fr;
```

In this very limited case, that’s equivalent to saying

```
grid-template-columns: 25% 25% 25% 25%;
```

The result either way is shown in [Figure 4-12](#).



**Figure 4-12. Dividing the container into four columns**

Now suppose we want to add a fifth column, and redistribute the column size so they're all still equal. With percentages, we'd have to rewrite the entire value to be five instances of 20%. With `fr`, though, we can just add another `1fr` to the value and have everything done for us automatically:

```
grid-template-columns: 1fr 1fr 1fr 1fr 1fr;
```

The way `fr` units work is that all of the `fr` values are added together, with the available space divided by that total. Then each track gets the number of those fractions indicated by its number.

What that meant for the first of the previous examples is that when there were four `fr` values, their numbers were added together to get a total of four. The available space was thus divided by four, and each column got one of those fourths. When we added a fifth `1fr`, the space was divided by five, and each column got one of those fifths.

You are not required to always use `1` with your `fr` units! Suppose you want to divide up a space such that there are three columns, with the middle column twice as wide as the other two. That would look like this:

```
grid-template-columns: 1fr 2fr 1fr;
```

Again, these are added up and then `1` is divided by that total, so the base `fr` in this case is `0.25`. The first and third tracks are thus 25% the width of the container, whereas the middle column is half the container's width, because it's `2fr`, which is twice `0.25`, or `0.5`.

You aren't limited to integers, either. A recipe card for apple pie could be laid out using these columns:

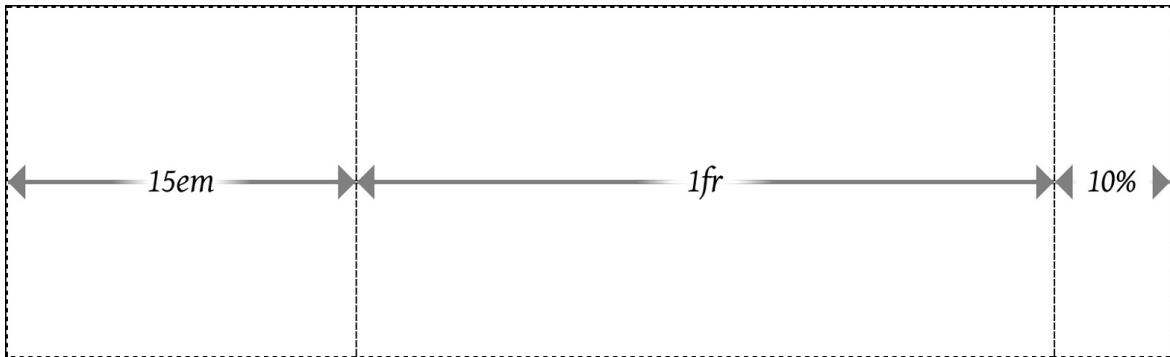
```
grid-template-columns: 1fr 3.14159fr 1fr;
```

I'll leave the math on that one as an exercise for the reader. (Lucky you! Just remember to start with `1 + 3.14159 + 1`, and you'll have a good head start.)

This is a convenient way to slice up a container, obviously, but there's more

here than just replacing percentages with something more intuitive. Fractional units really come into their own when there are some fixed columns and some flexible space. Consider, for example, the following, which is illustrated in [Figure 4-13](#):

```
grid-template-columns: 15em 1fr 10%;
```



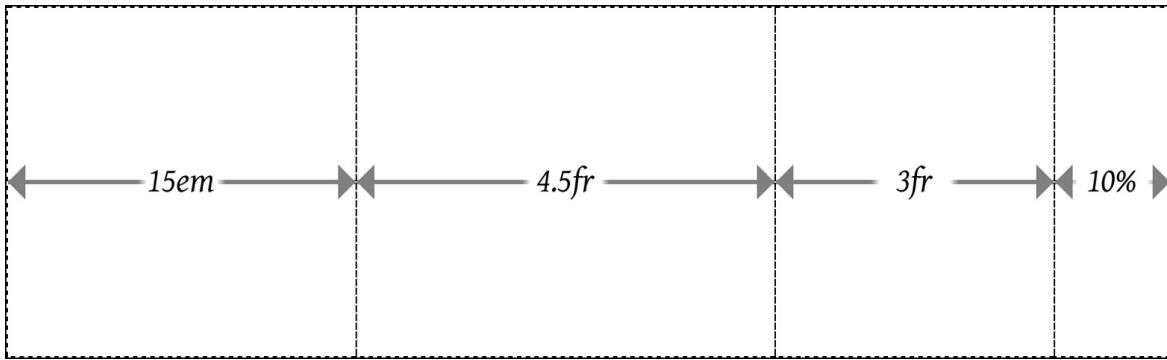
**Figure 4-13. Giving the center column whatever's available**

What happened there is that the browser assigned the first and third tracks to their inflexible widths, and then gave whatever was left in the grid container to the center track. This means that for a 1,000-pixel-wide grid container whose `font-size` is the usual browser default of `16px`, the first column will be 240 pixels wide and the third will be 100 pixels wide. That totals 340 pixels, leaving 660 pixels unassigned to inflexible tracks. The fractional units total one, so 660 is divided by one, yielding 660 pixels, all of which are given to the single `1fr` track. If the grid container's width is increased to 1,400 pixels, the third column will be 140 pixels wide and the center column 1,020 pixels wide.

Just like that, we have a mixture of fixed and flexible columns. We can keep this going, splitting up any flexible space into as many fractions as we like. Consider this:

```
width: 100em; grid-template-columns: 15em 4.5fr 3fr 10%;
```

In this case, the columns will be sized as shown in [Figure 4-14](#).



**Figure 4-14. Flexible column sizing**

Yes, admittedly, I put a thumb on the scales for [Figure 4-14](#): the `fr` total and `width` value were engineered to yield nice, round numbers for the various columns. This is purely to aid understanding, of course. If you want to work through the process with less tidy numbers, consider using `92.5em` or `1234px` for the `width` value in the previous example.

In cases where you want to define a minimum or maximum size for a given track, `minmax()` can be quite useful in some situations. To extend the previous example, suppose the third column should never be less than `5em` wide, no matter what. The CSS would then be

```
grid-template-columns: 15em 4.5fr minmax(5em, 3fr) 10%;
```

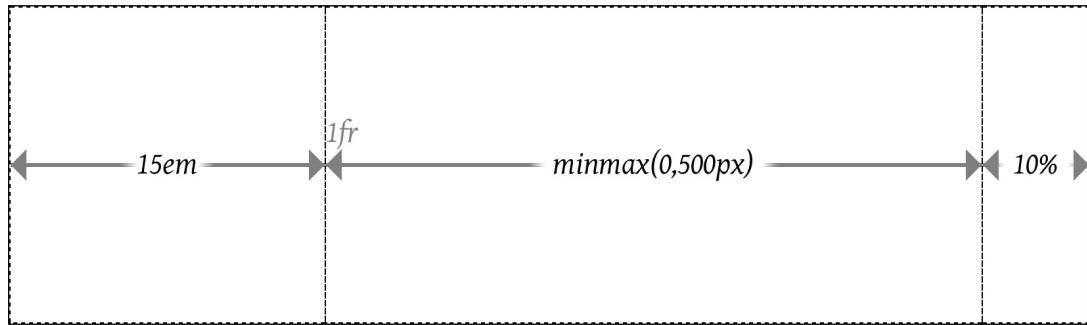
Now the layout will have two flexible columns at its middle, down to the point that the third column reaches `5em` wide. Below that point, the layout will have three inflexible columns (`15em`, `5em`, and `10%` wide, respectively) and a single flexible column that will get all the leftover space, if there is any. Once you run the math, it turns out that up to `30.5556em` wide, the grid will have one flexible column. Above that width, there will be two such columns.

You might think that this works the other way—for example, if you wanted to make a column track flexible up to a certain point, and then become fixed after, you would declare a minimum `fr` value. This won't work, sadly, because `fr` units are not allowed in the `min` position of a `minmax()` expression. So any `fr` value provided as a minimum will invalidate the declaration. (In earlier implementations, a minimum `fr` was set to zero. In future implementations, `fr` values will likely be allowed to be minimum sizes.)

Speaking of setting to zero, let's look at a situation where the minimum value is explicitly set to 0, like this:

```
grid-template-columns: 15em 1fr minmax(0, 500px) 10%;
```

[Figure 4-15](#) illustrates the narrowest grid width at which the third column can remain 500 pixels wide. Any narrower, and the minmaxed column will be narrower than 500 pixels. Any wider, and the second column, the `fr` column, will grow beyond zero width while the third column stays at 500 pixels wide.



**Figure 4-15. Minmaxed column sizing**

If you look closely, you'll see the `1fr` label next to the boundary between the `15em` and `minmax(0, 500px)` columns. That's there because the `1fr` is placed with its left edge on the second column grid line, and has no width, because there is no space left to flex. Similarly, the `minmax` is placed on the third column grid line. It's just that, in this specific situation, the second and third column grid lines are in the same place (which is why the `1fr` column has zero width).

If you ever run into a case where the minimum value is greater than the maximum value, then the whole thing is replaced with the minimum value. Thus, `minmax(500px, 200px)` would be treated as a simple `500px`. You probably wouldn't do this so obviously, but this feature is useful when mixing things like percentages and fractions. Thus, you could have a column that's `minmax(10%, 1fr)` that would be flexible down to the point where the flexible column was less than 10% of the grid container's width, at which point it would stick at 10%.

Fractional units and minmaxes are usable on rows just as easily as columns; it's just that rows are rarely sized in this way. You could easily imagine setting up a layout where the masthead and footer are fixed tracks, while the content is flexible down to a certain point. That might look something like this:

```
grid-template-rows: 3em minmax(5em, 1fr) 2em;
```

That works okay, but it's a lot more likely that you'll want to size that row by the height of its content, not some fraction of the grid container's height. The next section shows exactly how to make that happen.

## Content-aware tracks

It's one thing to set up grid tracks that take up fractions of the space available to them, or that occupy fixed amounts of space. But what if you want to line up a bunch of pieces of a page and you can't guarantee how wide or tall they might get? This is where `min-content` and `max-content` come in.

What these keywords mean is simple to state, but not necessarily simple to describe in full. `max-content` means, in effect, “take up the maximum amount of space needed for this content.” For large blocks of text (like a blog post), this would generally mean taking as much room as is available, in order to maximize the space for that content.

`min-content`, by contrast, means “take up the bare minimum space needed for this content.” With text, that means squeezing the width down to the point that the longest word (or widest inline element, if there are things like images or form inputs) sits on a line by itself. That would lead to a lot of linebreaks in a very skinny, very tall grid element.

What's so powerful about these sizing keywords is that they apply to the entire grid track they define. For example, if you size a column to be `max-content`, then the entire column track will be as wide as the widest content within it. This is easiest to illustrate with a grid of images (12 in this case) with the grid declared as follows and shown in [Figure 4-16](#).

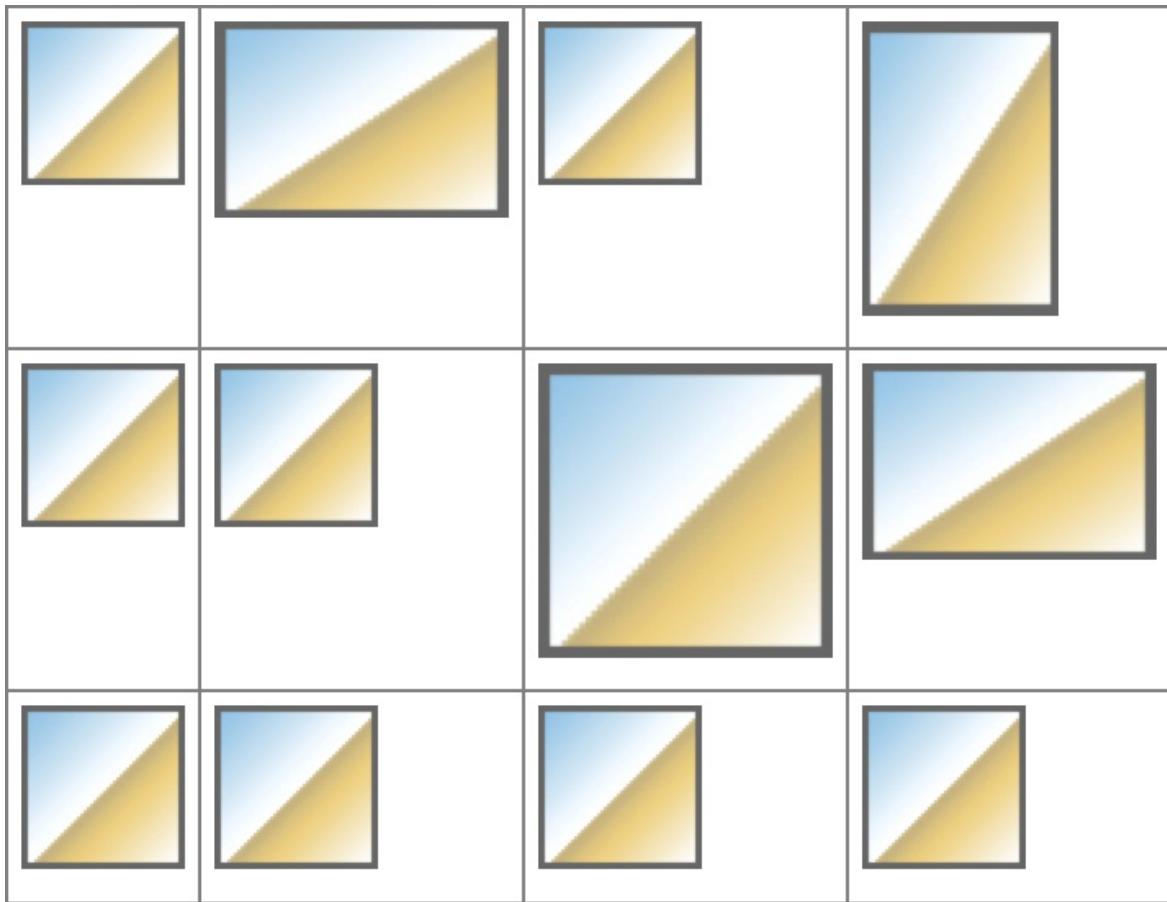
```
#gallery {display: grid;
```

```
grid-template-columns: max-content max-content max-content ma  
grid-template-rows: max-content max-content max-content; }
```

Looking at the columns, we can see that each column track is as wide as the widest image within that track. Where a bunch of portrait images happened to line up, the column is more narrow; where a landscape image showed up, the column was made wide enough to fit it. The same thing happened with the rows. Each row is as tall as the tallest image within it, so wherever a row happened to have all short images, the row is also short.

The advantage here is that this works for any sort of content, no matter what's in there. So let's say we add captions to the photos. All of the columns and rows will resize themselves as needed to handle both text and images, as shown in [Figure 4-17](#).

Obviously, this isn't a full-fledged design—the images are out of place, and there's no attempt to constrain the caption widths. In fact, that's exactly what we should expect from `max-content` values for the column widths. Since it means “make this column wide enough to hold all its content,” that's what we got.



**Figure 4-16.** Sizing grid tracks by content

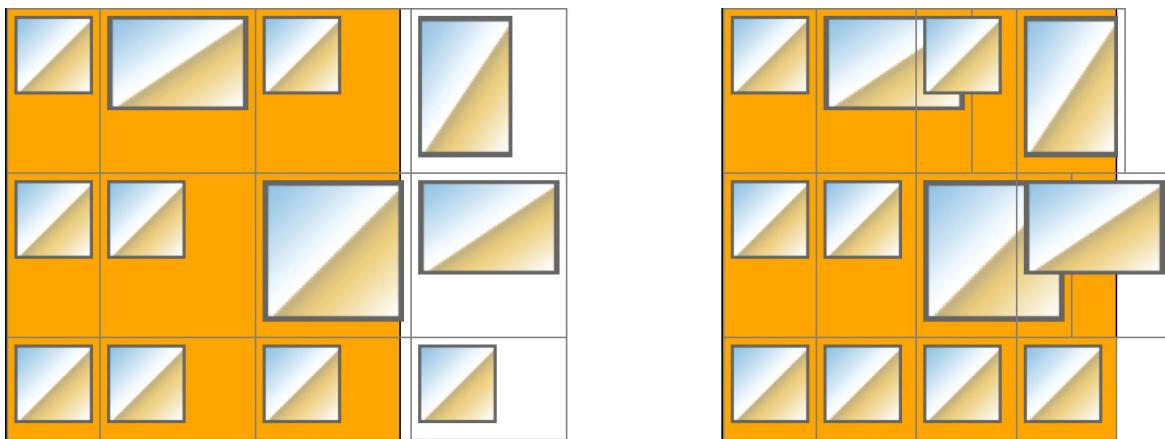
Fancy icon	A wide shot	Very circular, with a twist	A portrait in yellow
			This caption intentionally left blank

The table illustrates how grid tracks can be sized around mixed content. The first two columns contain small icons, while the third column contains a large circular icon and the fourth column contains a portrait-style icon. The last row shows that a caption can span multiple columns or be placed outside the grid entirely.

**Figure 4-17.** Sizing grid tracks around mixed content

What's important to realize is that this will hold even if the grid tracks have to spill out of the grid container. That means that even if we'd assigned something like `width: 250px` to the grid container, the images and captions would be laid out just the same. That's why things like `max-content` tend to appear in `minmax()` statements. Consider the following, where grids with and without `minmax()` appear side by side. In both cases, the grid container is represented by an orange background (see [Figure 4-18](#)):

```
#g1 {display: grid;
  grid-template-columns: max-content max-content max-content ma
  }
#g2 {display: grid;
  grid-template-columns: minmax(0,max-content)  minmax(0,max-co
    minmax(0,max-content) minmax(0,max-content);
}
```



**Figure 4-18. Sizing grid tracks with and without `minmax()`**

In the first instance, the grid items completely contain their contents, but they spill out of the grid container. In the second, the `minmax()` directs the browser to keep the columns within the range of `0` and `max-content`, so they'll all be fit into the grid container if possible. A variant on this would be to declare `minmax(min-content, max-content)`, which leads to a slightly different result than the `0, max-content` approach.

If you're wondering what happens if you `min-content` both the columns and the rows, it's pretty much the same as applying `min-content` to the columns and leaving the rows alone. This happens because the grid specification

directs browsers to resolve column sizing first, and row sizing after that.

There's one more keyword you can use with grid track sizing, which is `auto`. As a minimum, it's treated as the minimum size for the grid item, as defined by `min-width` or `min-height`. As a maximum, it's treated the same as `max-content`. You might think this means it can be used only in `minmax()` statements, but this is not the case. You can use it anywhere, and it will take on either a minimum or maximum role. Which one it takes on depends on the other track values around it, in ways that are frankly too complicated to get into here. As with so many other aspects of CSS, using `auto` is essentially letting the browser do what it wants. Sometimes that's fine, but in general you'll probably want to avoid it.

**Note**

There is a caveat to that last statement: `auto` values allow grid items to be resized by the `align-content` and `justify-content` properties, a topic we'll discuss in a later section. Since `auto` values are the only track-sizing values that permit this, there may be very good reasons to use `auto` after all.

Speaking of things to avoid, you've probably been wondering about the repetitive grid template values, and what happens if you need more than three or four grid tracks. Will you have to write out every single track width individually? Indeed not, as we'll see in the next section.

# Repeating Grid Lines

If you have a situation where you want to set up a bunch of grid lines, you probably don't want to have to type out every single one of them. Fortunately, `repeat()` is here to make sure you don't have to.

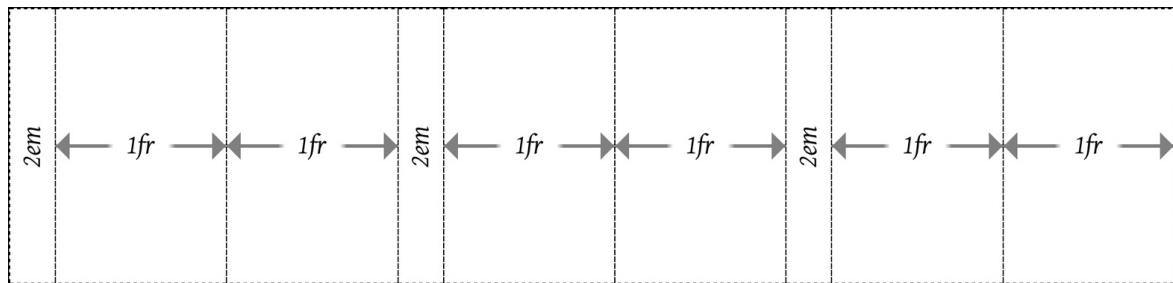
Let's say we want to set up a column grid line every 5 ems, and set up 10 column tracks. Here's how to do that:

```
#grid {display: grid;
       grid-template-columns: repeat(10, 5em);}
```

That's it. Done. Ten column tracks, each one `5em` wide, for a total of 50 ems of column tracks. It sure beats typing `5em` 10 times!

Any track-sizing value can be used in a `repeat`, from `min-content` and `max-content` to `fr` values to `auto`, and so on, and you can put together more than one sizing value. Suppose we want to define a column structure such that there's a `2em` track, then a `1fr` track, and then another `1fr` track—and, furthermore, we want to repeat that pattern three times. Here's how to do that, with the result shown in [Figure 4-19](#):

```
#grid {display: grid;
       grid-template-columns: repeat(3, 2em 1fr 1fr);}
```



**Figure 4-19.** Repeating a track pattern

Notice how the last column track is a `1fr` track, whereas the first column track is `2em` wide. This is an effect of the way the `repeat()` was written. It's

easy to add another `2em` track at the end, in order to balance things out, simply by making this change:

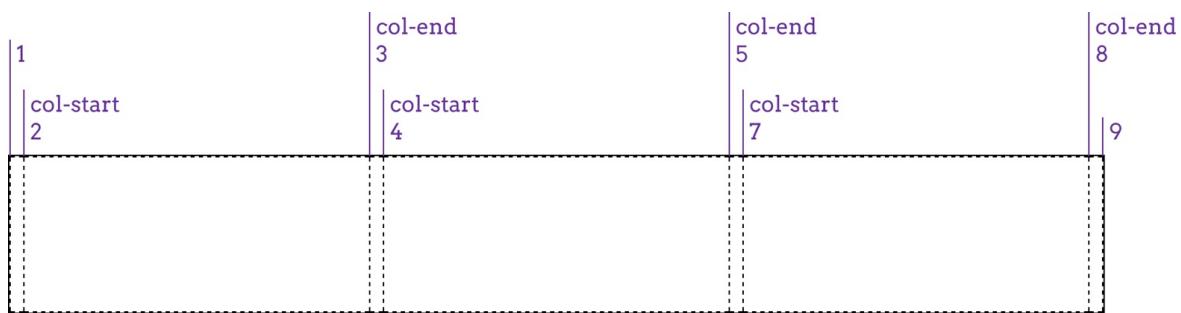
```
#grid {display: grid;
  grid-template-columns: repeat(3, 2em 1fr 1fr) 2em;}
```

See that extra `2em` at the end of the value? That adds one more column track after the three repeated patterns. This highlights the fact that `repeat` can be combined with any other track-sizing values—even other repeats—in the construction of a grid. The one thing you *can't* do is nest a `repeat` inside another `repeat`.

Other than that, just about anything goes within a `repeat()` value. Here's an example taken straight from the grid specification:

```
#grid {
  display: grid;
  grid-template-columns: repeat(4, 10px [col-start] 250px [col-
```

In this case, there are four repetitions of a 10-pixel track, a named grid line, a 250-pixel track, and then another named grid line. Then, after the four repetitions, a final 10-pixel column track. Yes, that means there will be four column grid lines named `col-start`, and another four named `col-end`, as shown in [Figure 4-20](#). This is acceptable; grid-line names are not required to be unique. (We'll see how to handle this sort of thing in a later section.)



**Figure 4-20. Repeated columns with named grid lines**

One thing to remember, if you're going to repeat named lines, is that if you place two named lines next to each other, they'll be merged into a single, double-named grid line. In other words, the following two declarations are

equivalent:

```
grid-template-rows: repeat(3, [top] 5em [bottom]);  
grid-template-rows: [top] 5em [bottom top] 5em [top bottom] 5em [
```

**Note**

If you're concerned about having the same name applied to multiple grid lines, don't be: there's nothing preventing it, and it can even be helpful in some cases. We'll explore ways to handle such situations in a later section.

## Auto-filling tracks

There's even a way to set up a simple pattern and repeat it until the grid container is filled. This doesn't have quite the same complexity as regular `repeat()` (at least not yet) but it can still be pretty handy.

For example, suppose we want to have the previous row pattern repeat as many times as the grid container will comfortably accept:

```
grid-template-rows: repeat(auto-fill, [top] 5em [bottom]);
```

That will define a row line every 5 ems until there's no more room. Thus, for a grid container that's 11 ems tall, the following is equivalent:

```
grid-template-rows: [top] 5em [bottom top] 5em [bottom];
```

If the grid container's height is increased past 15 ems, but is less than 20 ems, then this is an equivalent declaration:

```
grid-template-rows: [top] 5em [bottom top] 5em [top bottom] 5em [
```

The limitation with auto-repeating is that it can take only an optional grid-line name, a fixed track size, and another optional grid-line name. So `[top] 5em [bottom]` represents about the maximum value pattern. You can drop the named lines and just repeat `5em`, or just drop one of the names. It's not possible to repeat multiple fixed track sizes, nor can you repeat flexible track sizes. (Which makes sense: how many times would a browser repeat `1fr` to

fill out a grid container?)

**Note**

You might wish you could auto-repeat multiple track sizes in order to define “gutters” around your content columns. This is unnecessary because grids have a concept of (and properties to define) track gutters, which we’ll cover in a later section.

Furthermore, you can have only one auto-repeat in a given track template. Thus, the following would *not* be permissible:

```
grid-template-columns: repeat(auto-fill, 4em) repeat(auto-fill, 1
```

It makes sense that this isn’t permitted, once you look at it. If the first fills up the grid container with 4-em column tracks, where is there room for any repeated 100-pixel column tracks?

However, you *can* combine fixed-repeat tracks with auto-fill tracks. For example, you could start with three wide columns, and then fill the rest of the grid container with narrow tracks (assuming there’s space for them). That would look something like this:

```
grid-template-columns: repeat(3, 20em) repeat(auto-fill, 2em);
```

You can flip that around, too:

```
grid-template-columns: repeat(auto-fill, 2em) repeat(3, 20em);
```

That works because the grid layout algorithm assigns space to the fixed tracks first, and then fills up whatever space is left with auto-repeated tracks. The end result of that example is to have one or more auto-filled 2-em tracks, and then three 20-em tracks.

With `auto-fill`, you will always get at least one column, even if it won’t fit into the grid container for some reason. You’ll also get as many tracks as will fit, even if some of the tracks don’t have content in them. As an example, suppose you set up an auto-fill that placed five columns, but only the first three of them actually ended up with grid items in them. The other two would

remain in place, holding open layout space.

If you use `auto-fit`, on the other hand, then tracks that don't contain any grid items will be dropped. Suppose the following:

```
grid-template-columns: repeat(auto-fit, 20em);
```

If there's room for five column tracks in the grid container (i.e., it's more than 100 ems wide), but two tracks don't have any grid items to go into them, those empty grid tracks will be dropped, leaving the three column tracks that *do* contain grid items. The leftover space is handled in accordance with the values of `align-content` and `justify-content` (discussed in a later section).

**Warning**

There's a reason this section hasn't had any figures: as of early 2016, `auto-fill` and `auto-fit` had not been publicly implemented, though most grid-supporting browsers had announced plans to support them soon. Test thoroughly before use!

# Grid Areas

Do you remember ASCII art? Well, it's back, and thanks to the `grid-template-areas` property, you can use it to create complete grid templates!

## `grid-template-areas`

**Values:**      `none` | `<string>`

**Initial value:**      `none`

**Applies to:**      Grid containers

**Inherited:**      No

**Computed value:** As declared

We could go through a wordy description of how this works, but it's a lot more fun to just show it. The following rule has the result shown in [Figure 4-21](#):

```
#grid {display: grid;  
       grid-template-areas:  
         "h h h h"  
         "l c c r"  
         "l f f f";}
```



**Figure 4-21.** A simple set of grid areas

That's right: the letters in the string values are used to define how areas of the grid are shaped. Really! And you aren't even restricted to single letters! For example, we could expand the previous example like so:

```
#grid {display: grid;
grid-template-areas:
    "header     header     header     header"
    "leftside   content   content   rightside"
    "leftside   footer    footer    footer";}
```

The grid layout would be the same as that shown in [Figure 4-21](#), though the name of each area would be different (e.g., `footer` instead of `f`).

In defining template areas, the whitespace is collapsed, so you can use it (as I did in the previous example) to visually line up columns of names in the value of `grid-template-areas`. You could line them up with spaces or tabs, whichever will annoy your coworkers the most. Or you can just use a single space to separate each identifier, and not worry about the names lining up with each other. You don't even have to linebreak between strings; the following works just as well as a pretty-printed version:

```
grid-template-areas: "h h h h" "l c c r" "l f f f";
```

What you can't do is merge those separate strings into a single string and have it mean the same thing. Every new string (as delimited by the double quote marks) defines a new row in the grid. So the previous example, like the examples before it, defines three rows. If we merged them all into a single string, like so:

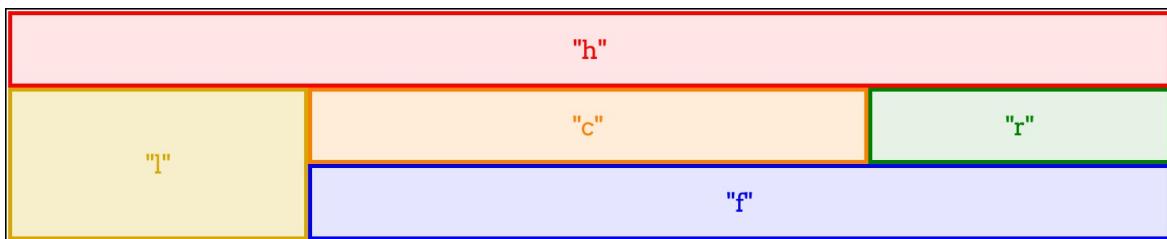
```
grid-template-areas:
  "h h h h
  l c c r"
```

```
l f f f";
```

...then we'd have a single row of twelve columns, starting with the four-column area `h` and ending with the three-column area `f`. The linebreaks aren't significant in any way, except as whitespace that separates one identifier from another.

If you look at these values closely, you may come to realize that each individual identifier represents a grid cell. Let's bring back our first example from this section, and consider the result shown in [Figure 4-22](#):

```
#grid {display: grid;
grid-template-areas:
  "h h h h"
  "l c c r"
  "l f f f";}
```



**Figure 4-22. Grid cells with identifiers**

This is exactly the same layout result, but here, we've shown how each grid identifier in the `grid-template-areas` value corresponds to a grid cell. Once all the cells are identified, the browser merges any adjacent cells with the same name into a single area that encloses all of them—as long as they describe a rectangular shape! If you try to set up more complicated areas, the entire template is invalid. Thus, the following would result in no grid areas being defined:

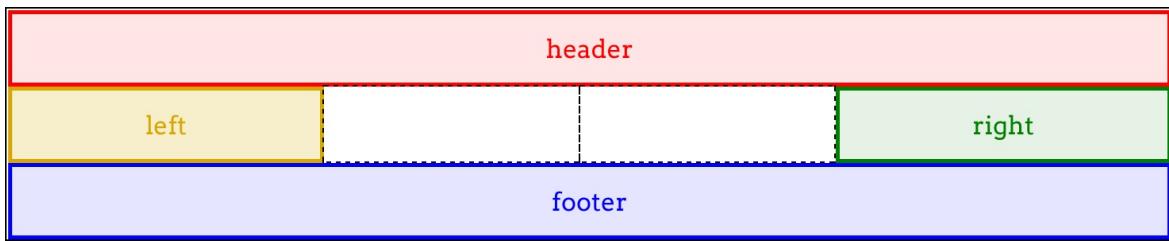
```
#grid {display: grid;
grid-template-areas:
  "h h h h"
  "l c c r"
  "l l f f";}
```

See how `l` outlines an “L” shape? That simple change causes the entire `grid-`

`template-areas` value to be dropped as invalid. A future version of grid layout may allow for nonrectangular shapes, but for now, this is what we have.

If you have a situation where you want to only define some grid cells to be part of grid areas, but leave others unlabeled, you can use one or more `.` characters to fill in for those unnamed cells. Let's say you just want to define some header, footer, and sidebar areas, and leave the rest unnamed. That would look something like this, with the result shown in [Figure 4-23](#):

```
#grid {display: grid;
  grid-template-areas:
    "header header header header"
    "left   ...   ...   right"
    "footer footer footer footer";}
```



**Figure 4-23.** A grid with some unnamed grid cells

The two grid cells in the center of the grid are not part of a named area, having been represented in the template by *null cell tokens* (the `.` identifiers). Where each of those `...` sequences appears, we could have used one or more null tokens—so `left . . right` or `left ..... right` would have worked just as well.

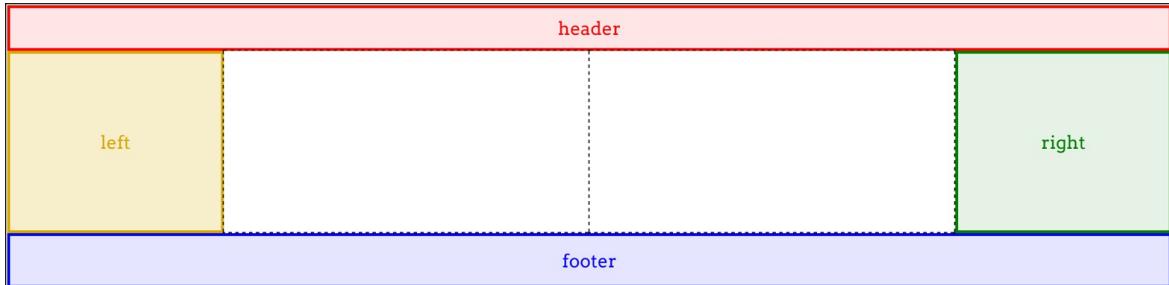
You can be as simple or creative with your cell names as you like. If you want to call your header `steve` and your footer `podiatrist`, go for it. You can even use any Unicode character above codepoint U+0080, so `ConHugeCo©®™` and `åwësømë` are completely valid area identifiers.

Now, to size the grid tracks created by these areas, we bring in our old friends `grid-template-columns` and `grid-template-rows`. Let's add both to the previous example, with the result shown in [Figure 4-24](#):

```

#grid {display: grid;
  grid-template-areas:
    "header header header header"
    "left ... ... right"
    "footer footer footer footer";
  grid-template-columns: 1fr 20em 20em 1fr;
  grid-template-rows: 40px 10em 3em; }

```



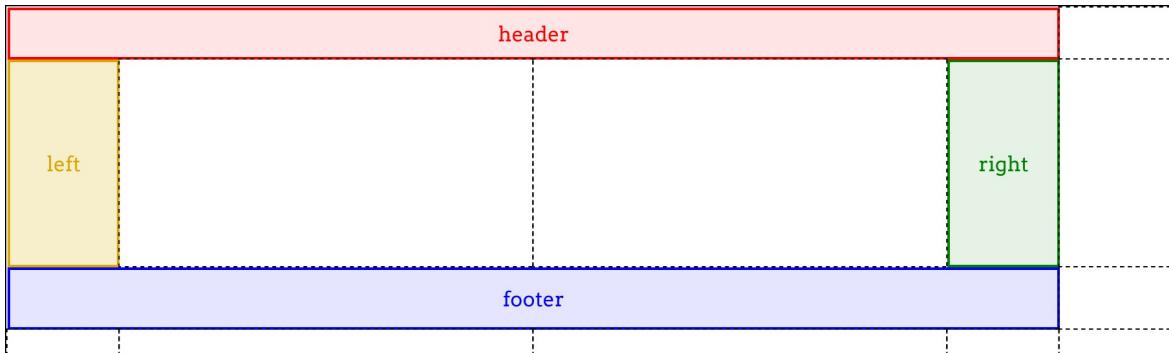
**Figure 4-24.** Named areas and sized tracks

Thus, the columns and rows created by naming the grid areas are given track sizes. If we give more track sizes than there are area tracks, that will simply add more tracks past the named areas. Therefore, the following CSS will lead to the result shown in [Figure 4-25](#):

```

#grid {display: grid;
  grid-template-areas:
    "header header header header"
    "left ... ... right"
    "footer footer footer footer";
  grid-template-columns: 1fr 20em 20em 1fr 1fr;
  grid-template-rows: 40px 10em 3em 20px; }

```

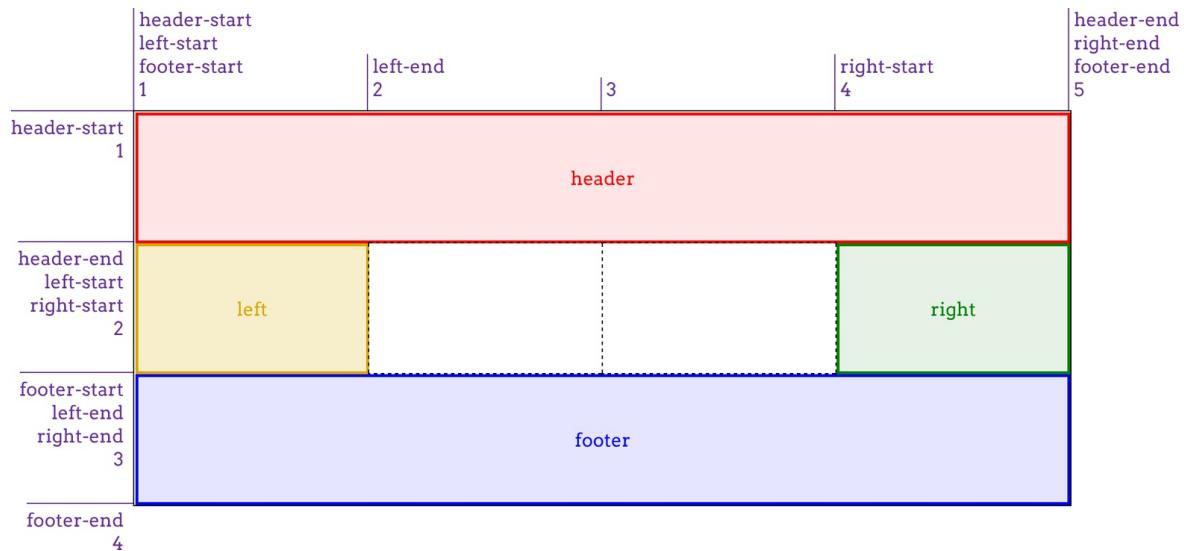


**Figure 4-25.** Adding more tracks beyond the named areas

So, given that we're naming areas, how about mixing in some named grid lines? As it happens, we already have: naming a grid area automatically adds names to the grid lines at its start and end. For the `header` area, there's an implicit `header-start` name on its first column-grid line *and* its first row-grid line, and `header-end` for its second column- and row-grid lines. For the `footer` area, the `footer-start` and `footer-end` names were automatically assigned to its grid lines.

Grid lines extend throughout the whole grid area, so a lot of these names are coincident. [Figure 4-26](#) shows the naming of the lines created by the following template:

```
grid-template-areas:
  "header header header header"
  "left   ...   ...   right"
  "footer footer footer footer";
```



**Figure 4-26. Implicit grid-line names made explicit**

Now let's mix it up even more by adding a couple of explicit grid-line names to our CSS. Given the following rules, the first column-grid line in the grid would add the name `begin`, and the second row-grid line in the grid would add the name `content`.

```
#grid {display: grid;
  grid-template-areas:
```

```

"header  header  header  header"
"left    ...     ...     right"
"footer  footer  footer  footer";
grid-template-columns: [begin] 1fr 20em 20em 1fr 1fr;
grid-template-rows: 40px [content] 1fr 3em 20px; }

```

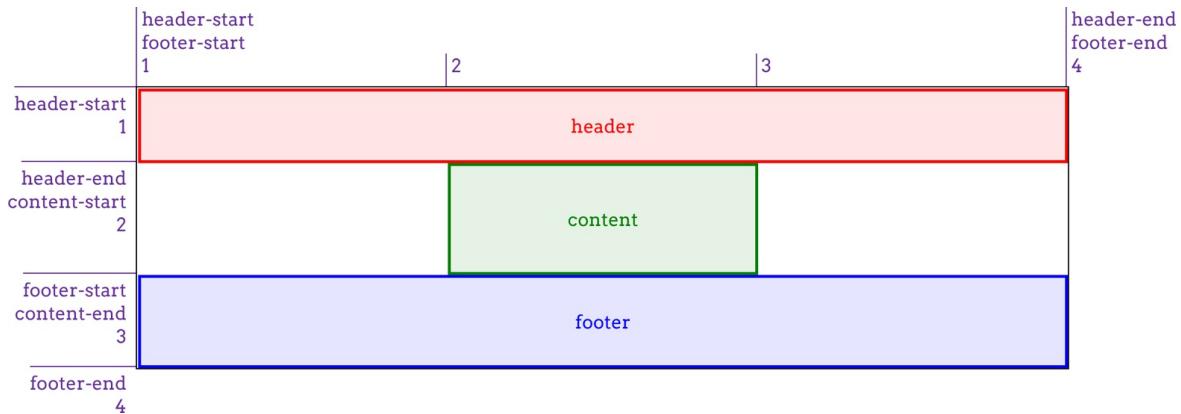
Again: those grid-line names are *added* to the implicit grid-line names created by the named areas. Interestingly enough, grid-line names never replace other grid-line names. Instead, they just keep piling up.

Even more interesting, this implicit-name mechanism runs in reverse. Suppose you don't use `grid-template-areas` at all, but instead set up some named grid lines like so, as illustrated in [Figure 4-27](#):

```

grid-template-columns:
  [header-start footer-start] 1fr
  [content-start] 1fr [content-end] 1fr
  [header-end footer-end];
grid-template-rows:
  [header-start] 3em
  [header-end content-start] 1fr
  [content-end footer-start] 3em
  [footer-end];

```



**Figure 4-27. Implicit grid-area names made explicit**

Because the grid lines use the form of `name-start/name-end`, the grid areas they define are implicitly named. To be frank, it's clumsier than doing it the other way, but the capability is there in case you ever want it.

Bear in mind that you don't need all four grid lines to be named in order to

create a named grid area, though you probably do need them all to create a named grid area where you want it to be. Consider the following simple example:

```
grid-template-columns: 1fr [content-start] 1fr [content-end]  
grid-template-rows: 3em 1fr 3em;
```

This will still create a grid area named `content`. It's just that the named area will be placed into a new row after all the defined rows. What's odd is that an extra, empty row will appear after the defined rows but before the row containing `content`. This has been confirmed to be the intended behavior. Thus, if you try to create a named area by naming the grid lines and miss one or more of them, then your named area will effectively hang off to one side of the grid instead of being a part of the overall grid structure.

So, again, you should probably stick to explicitly naming grid areas and letting the grid-line names happen implicitly, as opposed to the other way around.

# Attaching Elements to the Grid

Believe it or not, we've gotten this far without talking about how grid items are actually attached to a grid, once it's been defined.

# Using Column and Row Lines

There are a couple of ways to go about this, depending on whether you want to refer to grid lines or grid areas. We'll start with four simple properties that attach an element to grid lines.

**grid-row-start, grid-row-end, grid-column-start, grid-column-end**

**Values:** auto | <custom-ident> | [ <integer> && <custom-ident>? ] | [ span && [ <integer> || <custom-ident> ] ]

**Initial value:** auto

**Applies to:** Grid items and absolutely positioned elements, if their containing block is a grid container

**Inherited:** No

**Computed value:** As declared

What these properties do is let you say, “I want the edge of the element to be attached to grid line such-and-so.” As with so much of grid layout, it's a lot easier to show than to describe, so ponder the following styles and their result ([Figure 4-28](#)):

```
.grid {display: grid; width: 50em;  
grid-template-rows: repeat(5, 5em);  
grid-template-columns: repeat(10, 5em);}
```

```

.one {
  grid-row-start: 2; grid-row-end: 4;
  grid-column-start: 2; grid-column-end: 4; }
.two {
  grid-row-start: 1; grid-row-end: 3;
  grid-column-start: 5; grid-column-end: 10; }
.three {
  grid-row-start: 4;
  grid-column-start: 6; }

```

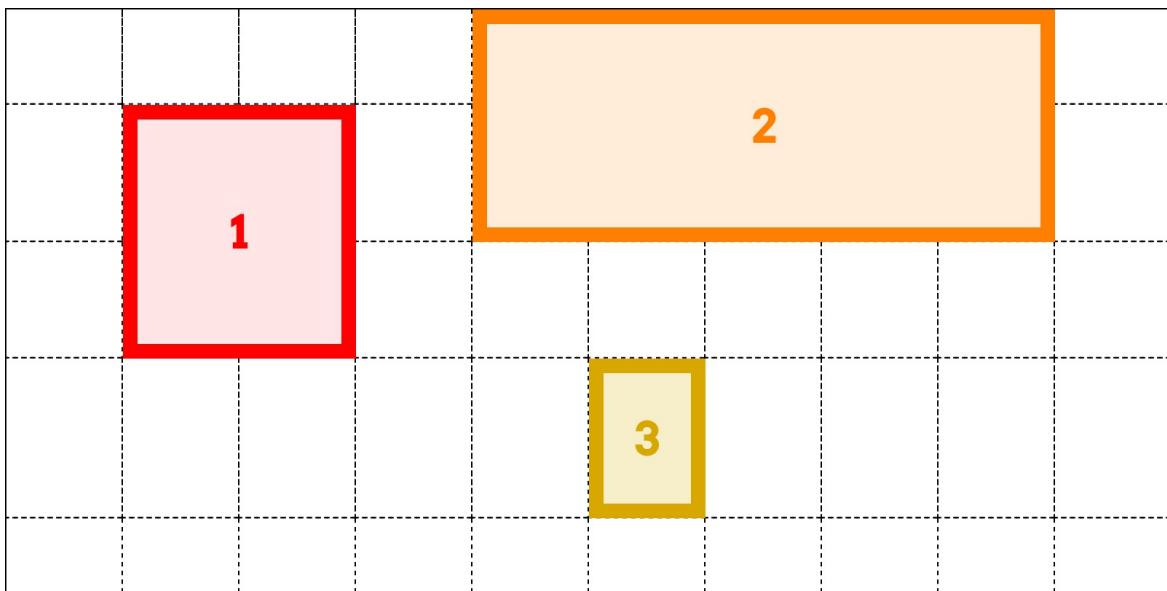
Here, we're using grid-line numbers to say where and how the elements should be placed within the grid. Column numbers count from left to right, and row numbers from top to bottom. Note that if you omit ending grid lines, as was the case for `.three`, then the next grid lines in sequence are used for the end lines.

Thus, the rule for `.three` in the previous example is exactly equivalent to the following:

```

.three {
  grid-row-start: 4; grid-row-end: 5;
  grid-column-start: 6; grid-column-end: 7; }

```



**Figure 4-28. Attaching elements to grid lines**

There's another way to say that same thing, as it happens: you could replace

the ending values with `span 1`, or even just plain `span`, like this:

```
.three {  
    grid-row-start: 4; grid-row-end: span 1;  
    grid-column-start: 6; grid-column-end: span; }  
}
```

If you supply `span` with a number, you're saying, "span across this many grid cells." So we could rewrite our earlier example like this, and get exactly the same result:

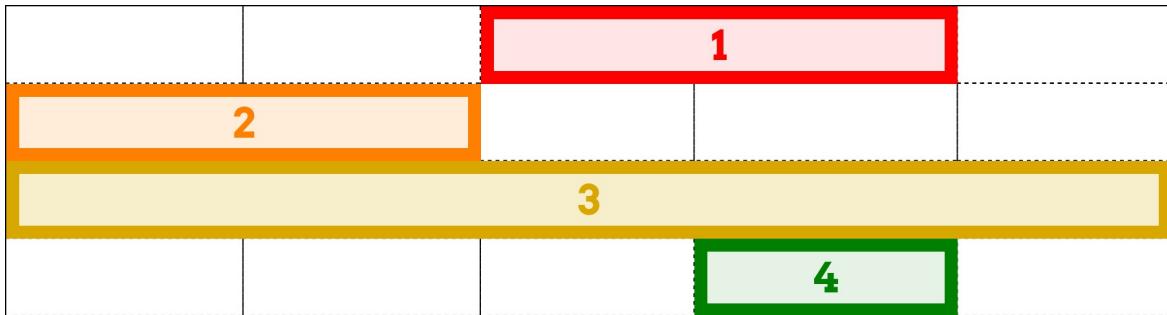
```
#grid {display: grid;
      grid-template-rows: repeat(5, 5em);
      grid-template-columns: repeat(10, 5em);}
.one {
  grid-row-start: 2; grid-row-end: span 2;
  grid-column-start: 2; grid-column-end: span 2;}
.two {
  grid-row-start: 1; grid-row-end: span 2;
  grid-column-start: 5; grid-column-end: span 5;}
.three {
  grid-row-start: 4; grid-row-end: span 1;
  grid-column-start: 6; grid-column-end: span;}
```

If you leave out a number for `span`, it's set to be 1. You can't use zero or negative numbers for `span`; only positive integers.

An interesting feature of `span` is that you can use it for both ending *and* starting grid lines. The precise behavior of `span` is that it counts grid lines in the direction “away” from the grid line where it starts. In other words, if you define a start grid line and set the ending grid line to be a `span` value, it will search toward the end of the grid. Conversely, if you define an ending grid line and make the start line a `span` value, then it will search toward the start of the grid.

That means the following rules will have the result shown in [Figure 4-29](#):

```
#grid {display: grid;
      grid-rows: repeat(4, 2em); grid-columns: repeat(5, 5em);}
.box01 {grid-row-start: 1; grid-column-start: 3; grid-column-end: 5;}
.box02 {grid-row-start: 2; grid-column-start: span 2; grid-column-end: 5;}
.box03 {grid-row-start: 3; grid-column-start: 1; grid-column-end: 5;}
.box04 {grid-row-start: 4; grid-column-start: span 1; grid-column-end: 5;}
```



**Figure 4-29. Spanning grid lines**

In contrast to `span` numbering, you aren't restricted to positive integers for your actual grid-line values. Negative numbers will simply count backward from the end of explicitly defined grid lines. Thus, to place an element into the bottom-right grid cell of a defined grid, regardless of how many columns or rows it might have, you can just say this:

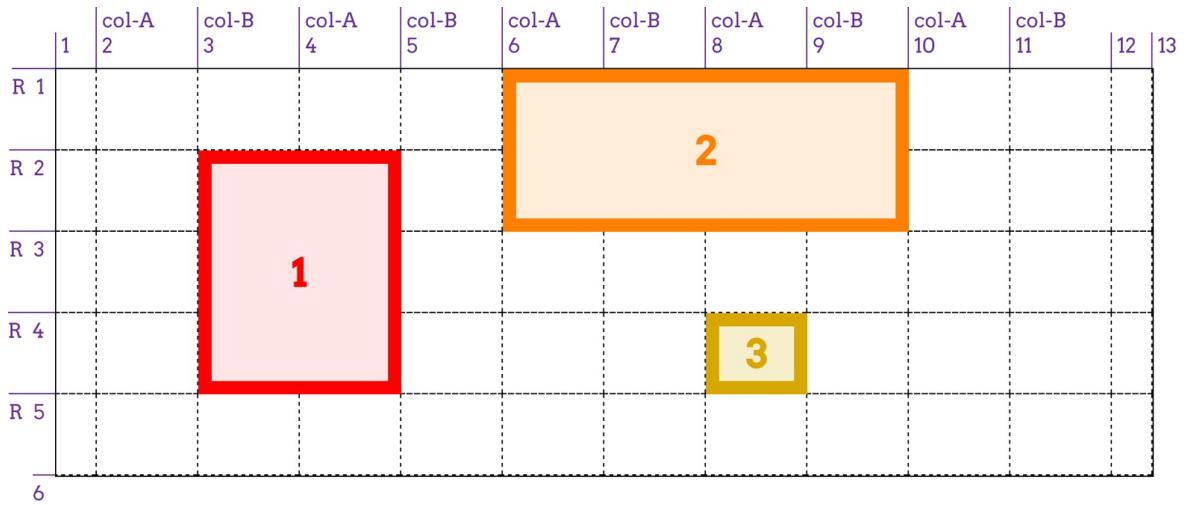
```
grid-column-start: -1;
grid-row-start: -1;
```

Note that this doesn't apply to any implicit grid tracks, a concept we'll get to in a bit, but only to the grid lines you explicitly define via one of the `grid-template-*` properties (e.g., `grid-template-rows`).

We aren't restricted to grid-line numbers, as it happens. If there are named grid lines, we can refer to those instead of (or in conjunction with) numbers. If you have multiple instances of a grid-line name, then you can use numbers to identify which instance of the grid-line name you're talking about. Thus, to start from the fourth instance of a row grid named `mast-slice`, you can say `mast-slice 4`. Take a look at the following, illustrated in [Figure 4-30](#), for an idea of how this works.

```
#grid {display: grid;
  grid-template-rows: repeat(5, [R] 4em);
  grid-template-columns: 2em repeat(5, [col-A] 5em [col-B] 5em)
.one {
  grid-row-start: R 2; grid-row-end: 5;
  grid-column-start: col-B; grid-column-end: span 2;}
.two {
  grid-row-start: R; grid-row-end: span R 2;
  grid-column-start: col-A 3; grid-column-end: span 2 col-A;}
```

```
.three {
  grid-row-start: 9;
  grid-column-start: col-A -2; }
```



**Figure 4-30. Attaching elements to named grid lines**

Notice how `span` changes when we add a name: where we said `span 2 col-A`, that caused the grid item to span from its starting point (the third `col-A`) across another `col-A` and end at the `col-A` after that. This means the grid item actually spans four grid cells, since `col-A` appears on every other column grid line.

Again, negative numbers count backward from the end of a sequence, so `col-A -2` gets us the second-from-last instance of a grid line named `col-A`. Because there are no end-line values declared for `.three`, they're both set to `span 1`. That means the following is exactly equivalent to the `.three` in the previous example:

```
.three {
  grid-row-start: 9; grid-row-end: span 1;
  grid-column-start: col-A -2; grid-row-end: span 1; }
```

There's an alternative way to use names with named grid lines—specifically, the named grid lines that are implicitly created by grid areas. For example, consider the following styles, illustrated in [Figure 4-31](#):

```
grid-template-areas:
  "header header header header"
```

```

"leftside    content    content    rightside"
"leftside    footer     footer     footer";
#masthead {grid-row-start: header;
            grid-column-start: header; grid-row-end: header;}
#sidebar {grid-row-start: 2; grid-row-end: 4;
            grid-column-start: leftside / span 1;}
#main {grid-row-start: content; grid-row-end: content;
            grid-column-start: content;}
#navbar {grid-row-start: rightside; grid-row-end: 3;
            grid-column-start: rightside;}
#footer {grid-row-start: 3; grid-row-end: span 1;
            grid-column-start: footer; grid-row-end: footer;}

```

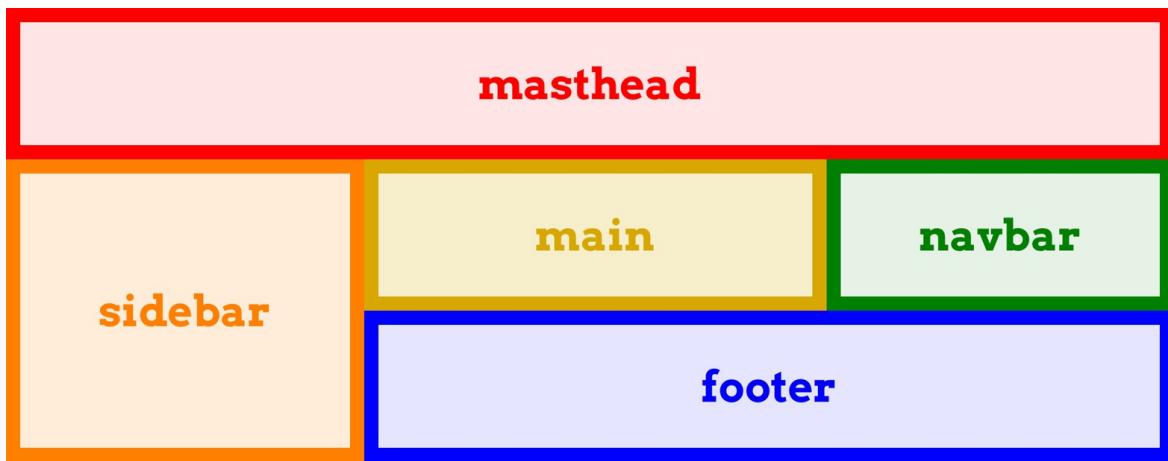


Figure 4-31. Another way of attaching elements to named grid lines

What happens if you supply a custom identifier (i.e., a name you defined) is that the browser looks for a grid line with that name *plus* either `-start` or `-end` added on, depending on whether you're assigning a start line or an end line. Thus, the following are equivalent:

```

grid-column-start: header; grid-column-end: header;
grid-column-start: header-start; grid-column-end: header-end;

```

This works because, as was mentioned with `grid-template-areas`, explicitly creating a grid area implicitly creates the named `-start` and `-end` grid lines that surround it.

The final value possibility, `auto`, is kind of interesting. According to the Grid Layout specification, if one of the grid-line start/end properties is set to `auto`, that indicates “auto-placement, an automatic span, or a default span of one.”

In practice, what this tends to mean is that the grid line that gets picked is governed by the *grid flow*, a concept we have yet to cover (but will soon!). For a start line, `auto` usually means that the next available column or row line will be used. For an end line, `auto` usually means a one-cell span. In both cases, the word “usually” is used intentionally: as with any automatic mechanism, there are no absolutes.

# Row and Column Shorthands

There are two shorthand properties that allow you to more compactly attach an element to grid lines.

## **grid-row, grid-column**

**Values:** <grid-line> [ / <grid-line> ]?

**Initial value:** auto

**Applies to:** Grid items and absolutely positioned elements, if their containing block is a grid container

**Inherited:** No

**Computed value:** As declared

**Note:** Is equivalent to the value syntax for `grid-column-start` et al.

The primary benefit of these properties is that they make it a lot simpler to declare the start and end grid lines to be used for laying out a grid item. For example:

```
#grid {display: grid;
  grid-template-rows: repeat(10, [R] 1.5em);
  grid-template-columns: 2em repeat(5, [col-A] 5em [col-B] 5em)
```

```

.one {
  grid-row: R 3 / 7;
  grid-column: col-B / span 2; }

.two {
  grid-row: R / span R 2;
  grid-column: col-A 3 / span 2 col-A; }

.three {
  grid-row: 9;
  grid-column: col-A -2; }

```

That's a whole lot easier to read than having each start and end value in its own property, honestly. Other than being more compact, the behavior of these properties is more or less what you'd expect. If you have two bits separated by a solidus, the first part defines the starting grid line and the second part defines the ending grid line.

If you have only one bit with no solidus, it defines the starting grid line. The ending grid line depends on what you said for the starting line. If you supply a name for the starting grid line, then the ending grid line is given that same name. Thus, the following are equivalent:

```

grid-column: col-B;
grid-column: col-B / col-B;

```

That will, of course, span from one instance of that grid-line name to the next, regardless of how many grid cells are spanned.

In cases where only one name is given for `grid-column` or `grid-row`, it is also used for the second (the end line). If a single number is given, then the second number (the end line) is set to `auto`. That means the following pairs are equivalent:

```

grid-row: 2;
grid-row: 2 / auto;

grid-column: header;
grid-column: header / header;

```

There's a subtle behavior built into the handling of grid-line names in `grid-row` and `grid-column` that pertains to implicitly named grid lines. If you recall, defining a named grid area creates `-start` and `-end` grid lines. That is,

given a grid area with a name of `footer`, there are implicitly created `footer-start` grid lines to its top and left, and `footer-end` grid lines to its bottom and right.

In that case, if you refer to those grid lines by the area's name, the element will still be placed properly. Thus, the following styles have the result shown in [Figure 4-32](#):

```
#grid {display: grid;
  grid-template-areas:
    "header header"
    "sidebar content"
    "footer footer";
  grid-template-rows: auto 1fr auto;
  grid-template-columns: 25% 75%;}
#header {grid-row: header / header; grid-column: header;}
#footer {grid-row: footer; grid-column: footer-start / footer-end}
```



**Figure 4-32.** Attaching to implicit grid lines via grid-area names

You can always explicitly refer to the implicitly named grid lines, but if you just refer to the grid area, things still work out. If you refer to a grid-line name that doesn't correspond to a grid area, then it falls back to the behavior discussed previously. In detail, it's the same as saying `line-name 1`, so the following two are equivalent:

```
grid-column: jane / doe;
grid-column: jane 1 / doe 1;
```

This is why it's risky to name grid lines the same as grid areas. Consider the following:

```
grid-template-areas:  
  "header header"  
  "sidebar content"  
  "footer footer"  
  "legal legal";  
grid-template-rows: auto 1fr [footer] auto [footer];  
grid-template-columns: 25% 75%;
```

This explicitly sets grid lines named `footer` above the “footer” row and below the “legal” row...and now there’s trouble ahead. Suppose we add this:

```
#footer {grid-column: footer; grid-row: footer;}
```

For the column lines, there’s no problem. `footer` gets expanded to `footer / footer`. The browser looks for a grid area with that name and finds it, so it translates `footer / footer` to `footer-start / footer-end`. The `#footer` element is attached to those implicit grid lines.

For `grid-row`, everything starts out the same. `footer` becomes `footer / footer`, which is translated to `footer-start / footer-end`. But that means the `#footer` will only be as tall as the “footer” row. It will *not* stretch to the second explicitly named `footer` grid line below the “legal” row, because the translation of `footer` to `footer-end` (due to the match between the grid-line name and the grid-area name) takes precedence.

The upshot of all this: it’s generally a bad idea to use the same name for grid areas and grid lines. You might be able to get away with it in some scenarios, but you’re almost always better off keeping your line and area names distinct, so as to avoid tripping over name-resolution conflicts.

# The Implicit Grid

Up to this point, we've concerned ourselves solely with explicitly defined grids: we've talked about the row and column tracks we define via properties like `grid-template-columns`, and how to attach grid items to the cells in those tracks.

But what happens if we try to place a grid item, or even just part of a grid item, beyond that explicitly created grid? For example, consider the following simple grid:

```
#grid {display: grid;
  grid-template-rows: 2em 2em;
  grid-template-columns: repeat(6, 4em);}
```

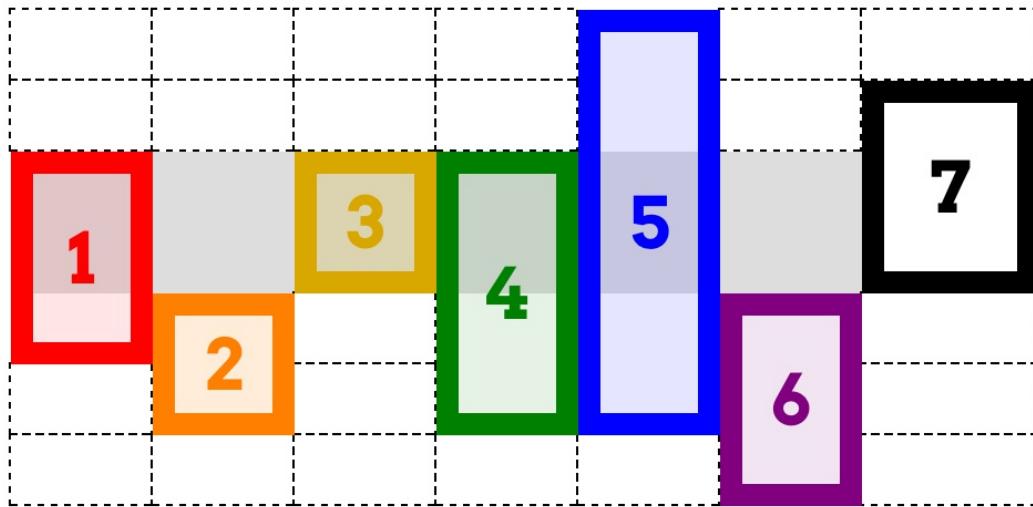
Two rows, six columns. Simple enough. But suppose we define a grid item to sit in the first column and go from the first grid line to the fourth:

```
.box01 {grid-column: 1; grid-row: 1 / 3;}
```

Now what? There are only two rows bounded by three grid lines, and we've told the browser to go beyond that, from line 1 to line 4.

What happens is that another row line is created to handle the situation. This grid line, and the new row track it creates, are both part of the *implicit grid*. Here are a few examples of grid items that create implicit grid lines (and tracks) and how they're laid out (see [Figure 4-33](#)):

```
.box01 {grid-column: 1; grid-row: 1 / 3;}
.box02 {grid-column: 2; grid-row: 3 / span 2;}
.box03 {grid-column: 3; grid-row: span 2 / 3;}
.box04 {grid-column: 4; grid-row: span 2 / 5;}
.box05 {grid-column: 5; grid-row: span 4 / 5;}
.box06 {grid-column: 6; grid-row: -1 / span 3;}
.box07 {grid-column: 7; grid-row: span 3 / -1;}
```



**Figure 4-33.** Creating implicit grid lines and tracks

There's a lot going on there, so let's break it down. First off, the explicit grid is represented by the light-gray box behind the various numbered boxes; all the dashed lines represent the implicit grid.

So, what about those numbered boxes? `box1` adds an extra grid line after the end of the explicit grid, as we discussed before. `box2` starts on the last line of the explicit grid, and spans forward two lines, so it adds yet another implicit grid line. `box3` ends on the last explicit grid line (line 3) and spans back two lines, thus starting on the first explicit grid line.

`box4` is where things really get interesting. It ends on the fifth row line, which is to say the second implicit grid line. It spans back three lines—and yet, it still starts on the same grid line as `box3`. This happens because spans have to start counting within the explicit grid. Once they start, they can continue on into the implicit grid (as happened with `box2`), but they *cannot* start counting within the implicit grid.

Thus, `box4` ends on row-line 5, but its span starts with grid-line 3 and counts back two lines (span 2) to arrive at line 1. Similarly, `box5` ends on line 5, and spans back four lines, which means it starts on row-line -2. Remember: span

counting must *start* in the explicit grid. It doesn't have to end there.

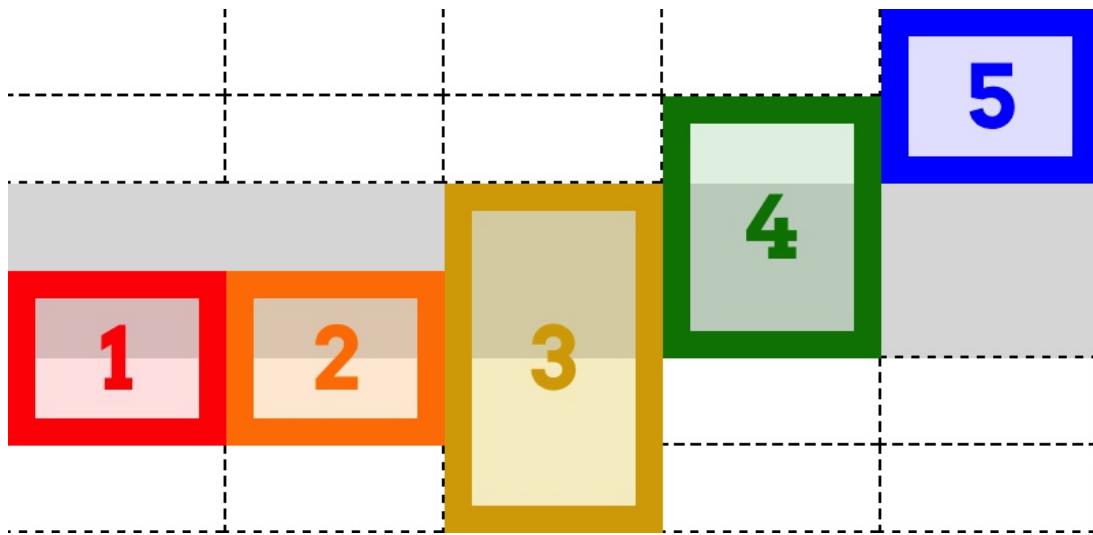
After those, `box6` is pretty straightforward: it starts on the last explicit row line (line 3), and spans out to the sixth row line—adding yet another implicit row line. The point of having it here is to show that negative grid-line references are with respect to the explicit grid, and count back from its end. They do *not* refer to negatively indexed implicit lines that are placed before the start of the explicit grid.

If you want to start an element on an implicit grid line before the explicit grid's start, then the way to do that is shown by `box7`: put its end line somewhere in the explicit grid, and span back past the beginning of the explicit grid. And you may have noticed: `box7` occupies an implicit column track. The original grid was set up to create six columns, which means seven column lines, the seventh being the end of the explicit grid. When `box7` was given `grid-column: 7`, that was equivalent to `grid-column: 7 / span 1` (since a missing end line is always assumed to be `span 1`). That necessitated the creation of an implicit column line in order to hold the grid item in the implicit seventh column.

Now let's take those principles and add named grid lines to the mix. Consider the following, illustrated in [Figure 4-34](#):

```
#grid {display: grid;
      grid-template-rows: [begin] 2em [middle] 2em [end];
      grid-template-columns: repeat(5, 5em);}
.box01 {grid-column: 1; grid-row: 2 / span end 2;}
.box02 {grid-column: 2; grid-row: 2 / span final;}
.box03 {grid-column: 3; grid-row: 1 / span 3 middle;}
.box04 {grid-column: 4; grid-row: span begin 2 / end;}
.box05 {grid-column: 5; grid-row: span 2 middle / begin;}
```

What you can see at work there, in several of the examples, is what happens with grid-line names in the implicit grid: every implicitly created line has the name that's being hunted. Take `box2`, for example. It's given an end line of `final`, but there is no line with that name. Thus the span-search goes to the end of the explicit grid and, having not found the name it's looking for, creates a new grid line, to which it attaches the name `final`.



**Figure 4-34.** Named implicit grid lines and tracks

Similarly, `box3` starts on the first explicit row line, and then needs to span three `middle` named lines. It searches forward and finds one, then goes looking for the other two. Not finding any, it attaches the name `middle` to the first implicit grid line, and then does the same for the second implicit grid line. Thus, it ends two implicit grid lines past the end of the explicit grid.

When you get right down to it, the implicit grid is a delightfully baroque fallback mechanism. It's generally best practice to stick to the explicit grid, and to make sure the explicit grid covers everything you want to do. If you find you need another row, don't just run off the edge of the grid—adjust your grid template's values instead!

# Error Handling

There are a few cases that need to be covered, as they fall under the general umbrella of “what grids do when things go pear-shaped.”

First, what if you accidentally put the start line after the end line? Say, something like this:

```
grid-row-start: 5;  
grid-row-end: 2;
```

All that happens is probably what was meant in the first place: the values are swapped. Thus, you end up with this:

```
grid-row-start: 2;  
grid-row-end: 5;
```

Second, what if both the start and the end lines are declared to be spans of some variety? For example:

```
grid-column-start: span;  
grid-column-end: span 3;
```

If this happens, the end value is dropped and replaced with `auto`. That means you'd end up with this:

```
grid-column-start: span; /* 'span' is equal to 'span 1' */  
grid-column-end: auto;
```

That would cause the grid item to have its ending edge placed automatically, according to the current grid flow (a subject we'll soon explore), and the starting edge to be placed one grid line earlier.

Third, what if the only thing directing placement of the grid item is a named span? In other words:

```
grid-row-start: span footer;  
grid-row-end: auto;
```

This is not permitted, so the `span footer` in this case is replaced with `span 1.`

# Using Areas

Attaching by row lines and column lines is great, but what if you could refer to a grid area with a single property? Behold: `grid-area`.

## `grid-area`

**Values:**     `<grid-line> [ / <grid-line> ]{0,3}`

**Initial value:**     See individual properties

**Applies to:**     Grid items and absolutely positioned elements, if their containing block is a grid container

**Inherited:**     No

**Computed value:**     As declared

**Note:**     Is equivalent to the value syntax for `grid-column-start` et al.

Let's start with the easier use of `grid-area`: assigning an element to a previously defined grid area. Makes sense, right? Let's bring back our old friend `grid-template-areas`, put it together with `grid-area` and some markup, and see what magic results (as shown in [Figure 4-35](#)):

```
#grid {display: grid;
      grid-template-areas:
```

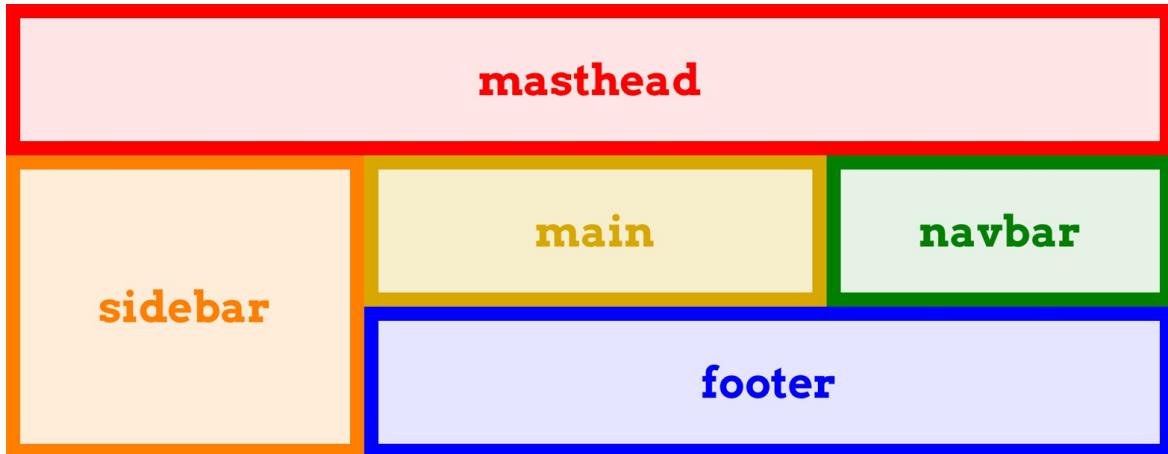
```

"header      header      header      header"
"leftside    content    content    rightside"
"leftside    footer     footer     footer";}

#masthead {grid-area: header;}
#sidebar {grid-area: leftside;}
#main {grid-area: content;}
#navbar {grid-area: rightside;}
#footer {grid-area: footer;}

<div id="grid">
  <div id="masthead">...</div>
  <div id="main">...</div>
  <div id="navbar">...</div>
  <div id="sidebar">...</div>
  <div id="footer">...</div>
</div>

```



**Figure 4-35. Assigning elements to grid areas**

That's all it takes: set up some named grid areas to define your layout, and then drop grid items into them with `grid-area`. So simple, and yet so powerful.

As you might have noticed, the sizing of the column and row tracks was omitted from that CSS. This was done entirely for clarity's sake. In an actual design, the rule probably would look more like this:

```

grid-template-areas:
  "header      header      header      header"
  "leftside    content    content    rightside"
  "leftside    footer     footer     footer";

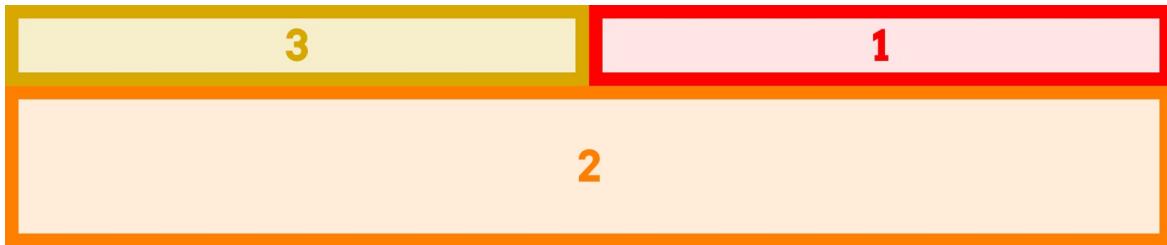
```

```
grid-template-rows: 200px 1fr 3em;  
grid-template-columns: 20em 1fr 1fr 10em;
```

There is another way to use `grid-area` that refers to grid lines instead of grid areas. Fair warning: it's likely to be confusing at first, for a couple of reasons.

Here's an example of a grid template that defines some grid lines, and some `grid-area` rules that reference the lines, as illustrated in [Figure 4-36](#):

```
#grid {display: grid;  
      grid-template-rows:  
        [r1-start] 1fr [r1-end r2-start] 2fr [r2-end];  
      grid-template-columns:  
        [col-start] 1fr [col-end main-start] 1fr [main-end];}  
.box01 {grid-area: r1 / main / r1 / main;}  
.box02 {grid-area: r2-start / col-start / r2-end / main-end;}  
.box03 {grid-area: 1 / 1 / 2 / 2;}
```



**Figure 4-36. Assigning elements to grid lines**

As you can see, the elements were placed as directed. Note the ordering of the grid-line values, however. They're listed in the order `row-start`, `column-start`, `row-end`, `column-end`. If you diagram that in your head, you'll quickly realize that the values go anticlockwise around the grid item—the exact opposite of the TRBL (Top, Right, Bottom, Left) pattern we're used to from margins, padding, borders, and so on. Furthermore, this means the column and row references are not grouped together, but are instead split up.

Yes, this is intentional. No, I don't know why.

If you supply fewer than four values, the missing values are taken from those you do supply. If there are only three values, then the missing `grid-column-end` is the same as `grid-column-start` if it's a name; if the start line is a number, the end line is set to `auto`. The same holds true if you give only two

values, except that the now-missing `grid-row-end` is copied from `grid-row-start` if it's a name; otherwise, it's set to `auto`.

From that, you can probably guess what happens if only one value is supplied: if it's a name, use it for all four values; if it's a number, the rest are set to `auto`.

This one-to-four replication pattern is actually how giving a single grid-area name translates into having the grid item fill that area. The following are equivalent:

```
grid-area: footer;  
grid-area: footer / footer / footer / footer;
```

Now recall the behavior discussed in the previous section about `grid-column` and `grid-row`: if a grid line's name matches the name of a grid area, then it's translated into a `-start` or `-end` variant, as appropriate. That means the previous example is translated to the following:

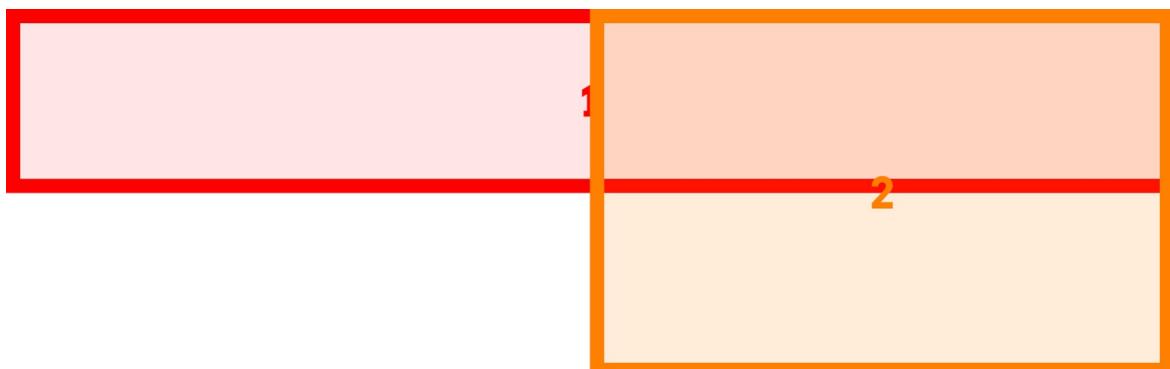
```
grid-area: footer-start / footer-start / footer-end / footer-end;
```

And that's how a single grid-area name causes an element to be placed into the corresponding grid area.

# Grid Item Overlap

One thing we've been very careful to do in our grid layouts thus far is to avoid overlap. Rather like positioning, it's absolutely (get it?) possible to make grid items overlap each other. Let's take a simple case, illustrated in [Figure 4-37](#):

```
#grid {display: grid;
      grid-template-rows: 50% 50%;
      grid-template-columns: 50% 50%;}
.box01 {grid-area: 1 / 1 / 2 / 3;}
.box02 {grid-area: 1 / 2 / 3 / 2;}
```



**Figure 4-37. Overlapping grid items**

Thanks to the grid numbers that were supplied, the two grid items overlap in the upper-right grid cell. Which is on top of the other depends on the layering behavior discussed later, but for now, just take it as given that they do layer when overlapping.

Overlap isn't restricted to situations involving raw grid numbers, of course. In the following case, the sidebar and the footer will overlap, as shown in [Figure 4-38](#). (Assuming the footer comes later than the sidebar in the markup, then in the absence of other styles, the footer will be on top of the sidebar.)

```
#grid {display: grid;
      grid-template-areas:
      "header header";}
```

```
"sidebar content"
"footer footer";}
#header {grid-area: header;}
#sidebar {grid-area: sidebar / sidebar / footer-end / sidebar;}
#footer {grid-area: footer;}
```



**Figure 4-38. Overlapping sidebar and footer**

I bring this up in part to warn you about the possibility of overlap, and also to serve as a transition to the next topic. It's a feature that sets grid layout apart from positioning, in that it can sometimes help avoid overlap: the concept of *grid flow*.

# Grid Flow

For the most part, we've been explicitly placing grid items on the grid. If items aren't explicitly placed, then they're automatically placed into the grid. Following the grid flow in effect, an item is placed in the first area that will fit it. The simplest case is simply filling a grid track in sequence, one grid item after another, but things can get a lot more complex than that, especially if there is a mixture of explicitly and automatically placed grid items—the latter must work around the former.

There are primarily two grid-flow models, *row-first* and *column-first*, though you can enhance either by specifying a *dense* flow. All this is done with the property `grid-auto-flow`.

## `grid-auto-flow`

**Values:** [ `row` | `column` ] || `dense`

**Initial value:** `row`

**Applies to:** Grid containers

**Inherited:** No

**Computed value:** As declared

To see how these values work, consider the following markup:

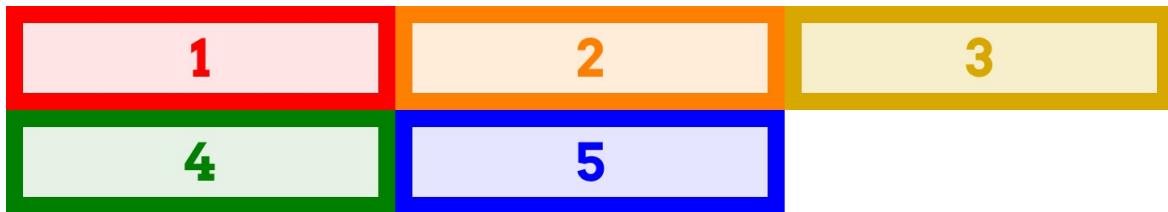
```
<ol id="grid">
<li>1</li>
```

```
<li>2</li>
<li>3</li>
<li>4</li>
<li>5</li>
</ol>
```

To that markup, let's apply the following styles:

```
#grid {display: grid; width: 45em; height: 8em;
       grid-auto-flow: row;}
#grid li {grid-row: auto; grid-column: auto;}
```

Assuming a grid with a column line every 15 ems and a row line every 4 ems, we get the result shown in [Figure 4-39](#).

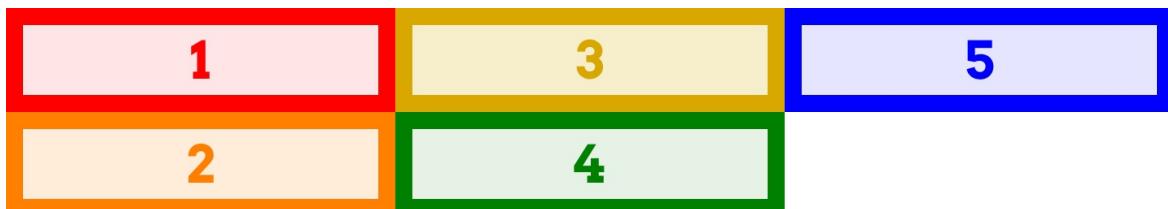


**Figure 4-39. Row-oriented grid flow**

This probably seems pretty normal, the same sort of thing you'd get if you floated all the boxes, or if all of them were inline blocks. That's why `row` is the default value. Now, let's try switching the `grid-auto-flow` value to `column`, as shown in [Figure 4-40](#):

```
#grid {display: grid; width: 45em; height: 8em;
       grid-auto-flow: column;}
#grid li {grid-row: auto; grid-column: auto;}
```

So with `grid-auto-flow: row`, each row is filled in before starting on the next row. With `grid-auto-flow: column`, each column is filled first.



**Figure 4-40. Column-oriented grid flow**

What needs to be stressed here is that the list items weren't explicitly sized. By default, they were resized to attach to the defined grid lines. This can be overridden by assigning explicit sizing to the elements. For example, if we make the list items be 7 ems wide and 1.5 ems tall, we'll get the result shown in [Figure 4-41](#):

```
#grid {display: grid; width: 45em; height: 8em;  
      grid-auto-flow: column;}  
#grid li {grid-row: auto; grid-column: auto;  
          width: 7em; height: 1.5em;}
```



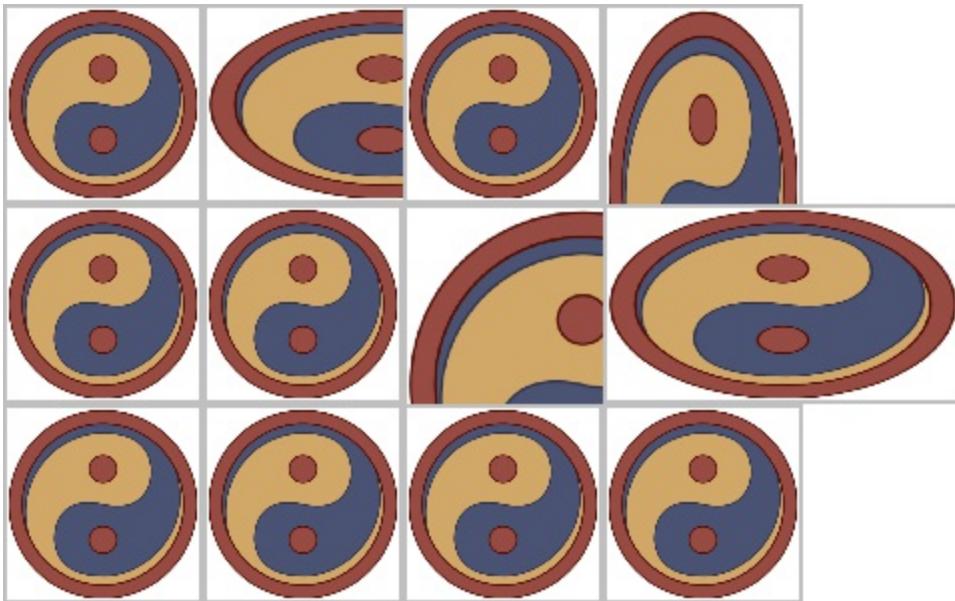
**Figure 4-41. Explicitly sized grid items**

If you compare that to the previous figure, you'll see that the corresponding grid items start in the same place in each figure; they just don't end in the same places. This illustrates that what's really placed in grid flow is grid areas, to which the grid items are then attached.

This is important to keep in mind if you auto-flow elements that are wider than their assigned column or taller than their assigned row, as can very easily happen when turning images or other intrinsically sized elements into grid items. Let's say we want to put a bunch of images, each a different size, into a grid that's set up to have a column line every 50 horizontal pixels, and a row line every 50 vertical pixels. This grid is illustrated in [Figure 4-42](#), along with the results of flowing a series of images into that grid by either row or column.

```
#grid {display: grid;  
      grid-template-rows: repeat(3, 50px);  
      grid-template-columns: repeat(4, 50px);  
      grid-auto-rows: 50px;  
      grid-auto-columns: 50px;  
}
```

```
img {grid-row: auto; grid-column: auto;}
```

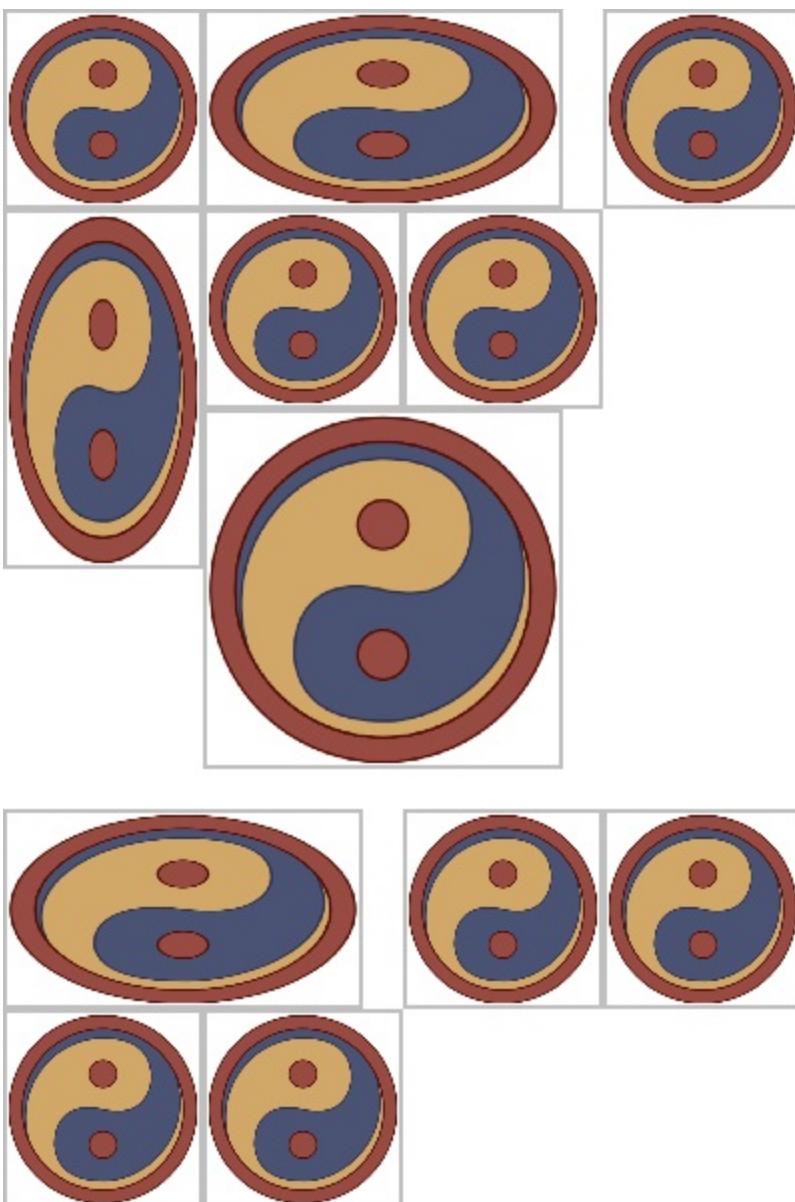


**Figure 4-42. Flowing images in grids**

Notice how some of the images overlap others? That's because each image is attached to the next grid line in the flow, without taking into account the presence of other grid items. We didn't set up images to span more than one grid track when they needed it, so overlap occurred.

This can be managed with class names or other identifiers. We could class images as `tall` or `wide` (or both) and specify that they get more grid tracks. Here's some CSS to add to the previous example, with the result shown in [Figure 4-43](#):

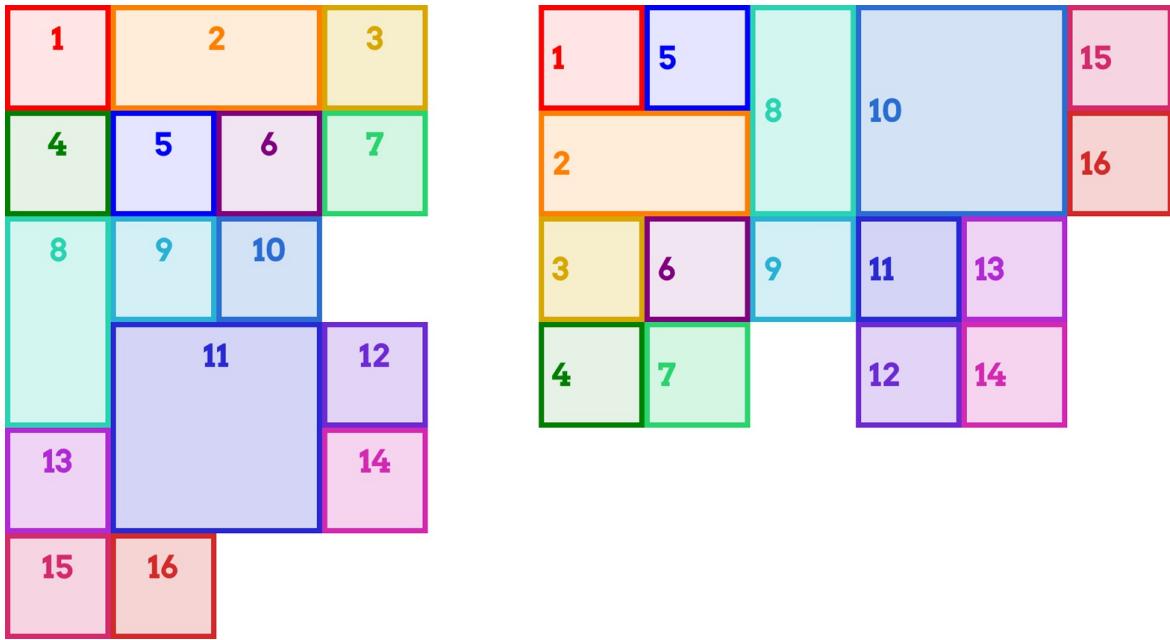
```
img.wide {grid-column: auto / span 2;}  
img.tall {grid-row: auto / span 2;}
```



**Figure 4-43.** Giving images more track space

This does cause the images to keep spilling down the page, but there's no overlapping.

However, notice how there are gaps in that last grid? That happened because the placement of some grid items across grid lines didn't leave enough room for other items in the flow. In order to illustrate this, and the two flow patterns, more clearly, let's try an example with numbered boxes ([Figure 4-44](#)).



**Figure 4-44. Illustrating flow patterns**

Follow across the rows of the first grid, counting along with the numbers. In this particular flow, the grid items are laid out almost as if they were leftward floats. Almost, but not quite: notice that grid item 13 is actually to the left of grid item 11. That would never happen with floats, but it can with grid flow. The way row flow (if we may call it that) works is that you go across each row from left to right, and if there's room for a grid item, you put it there. If a grid cell has been occupied by another grid item, you skip over it. So the cell next to item 10 didn't get filled, because there wasn't room for item 11. Item 13 went to the left of item 11 because there was room for it there when the row was reached.

The same basic mechanisms hold true for column flow, except in this case you work from top to bottom. Thus, the cell below item 9 is empty because item 10 wouldn't fit there. It went into the next column and spanned four grid cells. The items after it, since they were just one grid cell in size, filled in the cells after it in column order.

#### Note

Grid flow works left-to-right, top-to-bottom in languages that have that

writing pattern. In right-to-left languages, such as Arabic and Hebrew, the row-oriented flow would be right-to-left, not left-to-right.

If you were just now wishing for a way to pack grid items as densely as possible, regardless of how that affected the ordering, good news: you can! Just add the keyword `dense` to your `grid-auto-flow` value, and that's exactly what will happen. We can see the result in [Figure 4-45](#), which shows the results of `grid-auto-flow: row dense` and `grid-auto-flow: dense column` side by side.

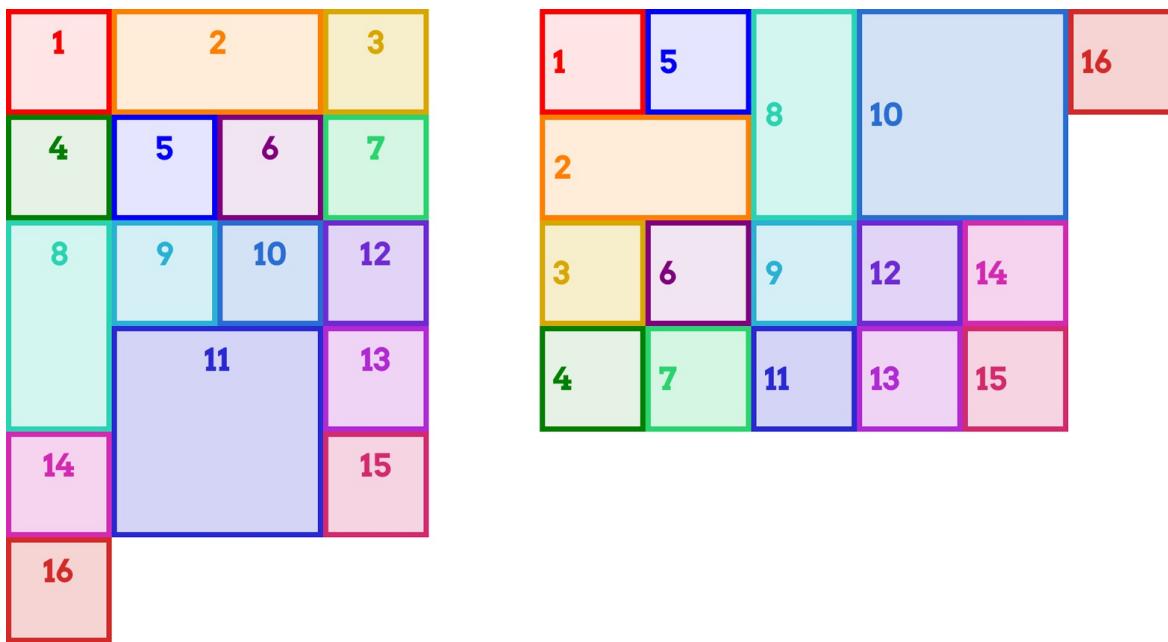


Figure 4-45. Illustrating dense flow patterns

In the first grid, item 12 appears in the row above item 11 because there was a cell that fit it. For the same reason, item 11 appears to the left of item 10 in the second grid.

In effect, what happens with `dense` grid flow is that for each grid item, the browser scans through the *entire* grid in the given flow direction (`row` or `column`), starting from the flow's starting point (the top-left corner, in LTR—left-to-right—languages), until it finds a place where that grid item will fit. This can make things like photo galleries more compact, and works great as long as you don't have a specific order in which the images need to appear.

Now that we've explored grid flow, I have a confession to make: in order to make the last couple of grid items look right, I included some CSS that I didn't show you. Without it, the items hanging off the edge of the grid would have looked quite a bit different than the other items—much shorter in row-oriented flow, and much narrower in column-oriented flow. We'll see why, and the CSS I used, in the next section.

# Automatic Grid Lines

So far, we've almost entirely seen grid items placed into a grid that was explicitly defined. But in the last section we had situations where grid items ran off the edge of the explicitly defined grid. What happens when a grid item goes off the edge? Rows or columns are added as needed to satisfy the layout directives of the items in question (see "[The Implicit Grid](#)"). So, if an item with a row span of 3 is added after the end of a row-oriented grid, three new rows are added after the explicit grid.

By default, these automatically added rows are the absolute minimum size needed. If you want to exert a little more control over their sizing, then `grid-auto-rows` and `grid-auto-columns` are for you.

## **grid-auto-rows, grid-auto-columns**

**Values:**       $\langle\text{track-breadth}\rangle \mid \text{minmax}(\langle\text{track-breadth}\rangle, \langle\text{track-breadth}\rangle)$

**Initial value:**      auto

**Applies to:** Grid containers

**Inherited:** No

**Computed value:** Depends on the specific track sizing

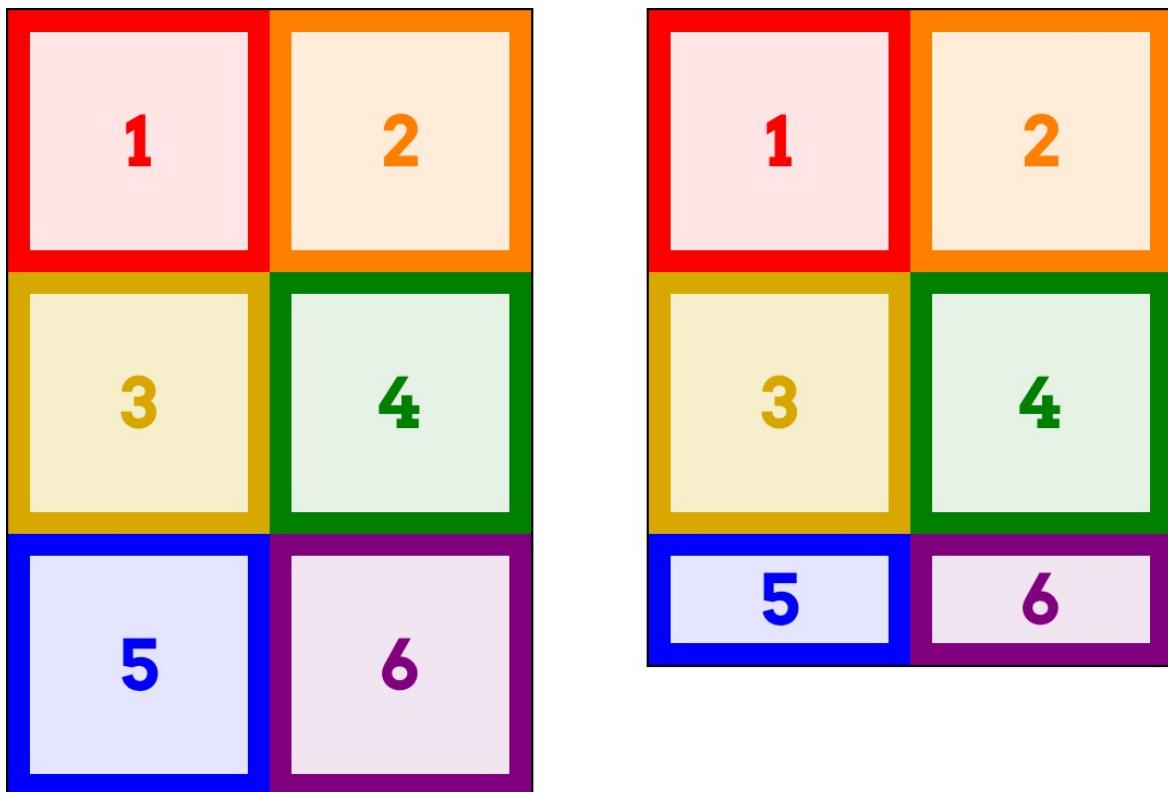
$\langle\text{track-breadth}\rangle$  is a stand-in for  $\langle\text{length}\rangle \mid \langle\text{percentage}\rangle \mid$

**Note**      `<flex> | min-content | max-content`

For any automatically created row or column tracks, you can provide a single track size or a minmaxed pair of track sizes. Let's take a look at a reduced version of the grid-flow example from the previous section: we'll set up a 2 x 2 grid, and try to put five items into it. In fact, let's do it twice: once with `grid-auto-rows`, and once without, as illustrated in [Figure 4-46](#):

```
.grid {display: grid;
  grid-template-rows: 80px 80px;
  grid-template-columns: 80px 80px; }
#g1 {grid-auto-rows: 80px;}
```

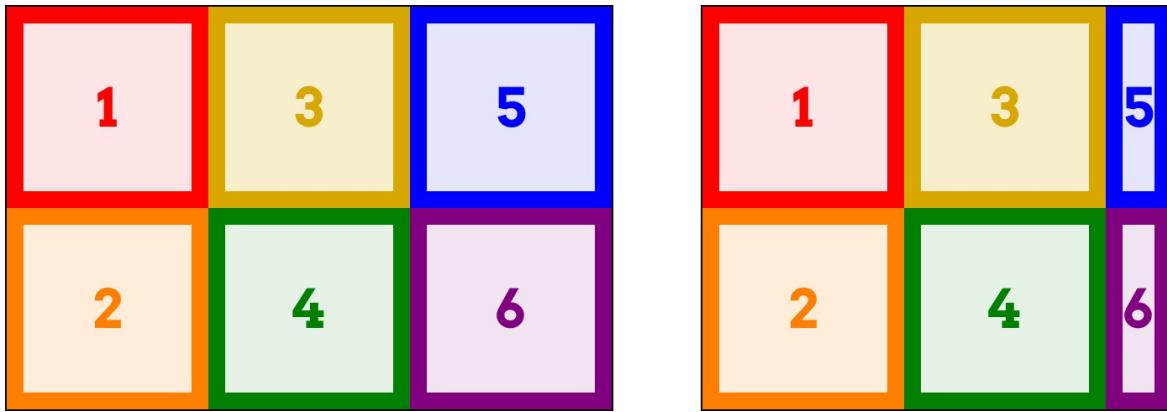
As you can see, without sizing the automatically created row, the grid item is placed in a row that's exactly as tall as the grid item's content, and not a pixel more. It's still just as wide as the column into which it's placed, because that has a size (80px). The row, lacking an explicit height, defaults to `auto`, with the result shown.



**Figure 4-46.** Grids with and without auto-row sizing

If we flip it around to columns, the same basic principles apply (see [Figure 4-47](#)):

```
.grid {display: grid; grid-auto-flow: column;
      grid-template-rows: 80px 80px;
      grid-template-columns: 80px 80px; }
#g1 {grid-auto-columns: 80px;}
```



**Figure 4-47.** Grids with and without auto-column sizing

In this case, because the flow is column-oriented, the last grid item is placed into a new column past the end of the explicit grid. In the second grid, where there's no `grid-auto-columns`, that fifth item is as tall as its row (80px), but has an `auto` width, so it's just as wide as it needs to be and no wider. Of course, if a sixth item were added and it had wider content, then the column would be sized to fit that content, thus widening the fifth item.

So now you know what I used in the `grid-auto-flow` figures in the previous section: I silently made the auto-rows and auto-columns the same size as the explicitly sized columns, in order to not have the last couple of items look weird. Let's bring back one of those figures, only this time the `grid-auto-rows` and `grid-auto-columns` styles will be removed. As you can see in [Figure 4-48](#), the last few items in each grid are shorter or narrower than the rest, due to the lack of auto-track sizing.

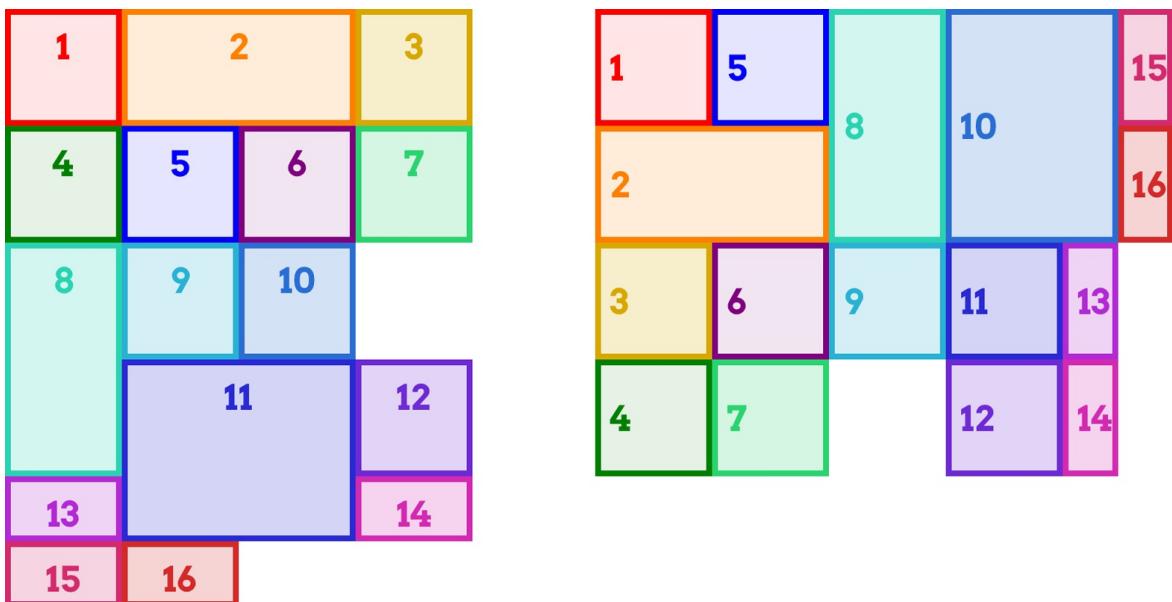


Figure 4-48. A previous figure with auto-track sizing removed

And now you know...the rest of the story.

# The grid Shorthand

At long last, we've come to the shorthand property `grid`. It might just surprise you, though, because it's not like other shorthand properties.

## `grid`

**Values:** `none | subgrid | [ <grid-template-rows> / <grid-template-columns> ] | [ <line-names>? <string> <track-size>? <line-names>? ]+ [ / <track-list> ]? | [ <grid-auto-flow> [ <grid-auto-rows> [ / <grid-auto-columns> ]? ]? ] ]`

**Initial value:** See individual properties

**Applies to:** Grid containers

**Inherited:** No

**Computed value:** See individual properties

The syntax is a little bit migraine-inducing, I admit, but we'll step through it a piece at a time.

Let's get to the elephant in the room right away: `grid` allows you to either define a grid template *or* you can set the grid's flow and auto-track sizing in a compact syntax. You can't do both at the same time.

Furthermore, whichever you don't define is reset to its defaults, as is normal for a shorthand property. So if you define the grid template, then the flow and auto tracks will be returned to their default values. This includes grid gutters, a topic we haven't even covered yet. You can't set the gutters with `grid`, but it will reset them anyway.

Yes, this is intentional. No, I don't know why.

So let's talk about creating a grid template using `grid`. The values can get fiendishly complex, and take on some fascinating patterns, but can be very handy. As an example, the following rule is equivalent to the set of rules that follows it:

```
grid:  
    "header header header header" 3em  
    ". content sidebar ." 1fr  
    "footer footer footer footer" 5em /  
    2em 3fr minmax(10em,1fr) 2em;  
  
grid-template-areas:  
    "header header header header"  
    ". content sidebar ."  
    "footer footer footer footer";  
grid-template-rows: 3em 1fr 5em;  
grid-template-columns: 2em 3fr minmax(10em,1fr) 2em;
```

Notice how the value of `grid-template-rows` is broken up and scattered around the strings of `grid-template-areas`. That's how row sizing is handled in `grid` when you have grid-area strings present. Take those strings out, and you end up with the following:

```
grid:  
    3em 1fr 5em / 2em 3fr minmax(10em,1fr) 2em;
```

In other words, the row tracks are separated by a solidus (/) from the column tracks.

Remember that with `grid`, undeclared shorthands are reset to their defaults. That means the following two rules are equivalent:

```
#layout {display: grid;  
        grid: 3em 1fr 5em / 2em 3fr minmax(10em,1fr) 2em;}
```

```
#layout {display: grid;
  grid: 3em 1fr 5em / 2em 3fr minmax(10em,1fr) 2em;
  grid-auto-rows: auto;
  grid-auto-columns: auto;
  grid-auto-flow: row;}
```

Therefore, make sure your `grid` declaration comes before anything else related to defining the grid. That means that if we wanted a dense column flow, we'd write something like this:

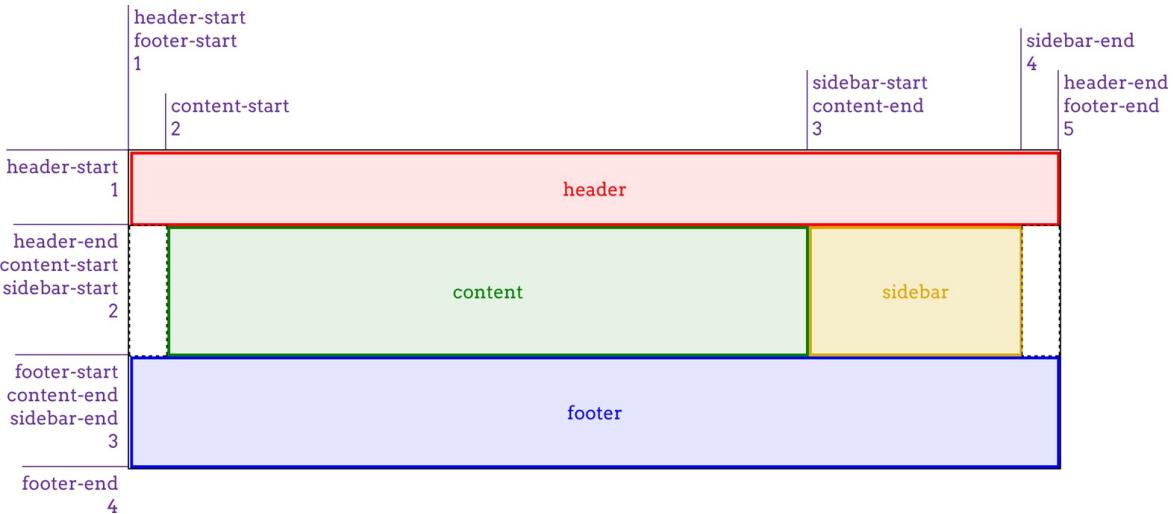
```
#layout {display: grid;
  grid: 3em 1fr 5em / 2em 3fr minmax(10em,1fr) 2em;
  grid-auto-flow: dense column;}
```

Now, let's bring the named grid areas back, *and* add some extra row grid-line names to the mix. A named grid line that goes *above* a row track is written *before* the string, and a grid line that goes *below* the row track comes *after* the string and any track sizing. So let's say we want to add `main-start` and `main-stop` above and below the middle row, and `page-end` at the very bottom:

```
grid:
  "header header header header" 3em
  [main-start] ". content sidebar ." 1fr [main-stop]
  "footer footer footer footer" 5em [page-end] /
  2em 3fr minmax(10em,1fr) 2em;
```

That creates the grid shown in [Figure 4-49](#), with the implicitly created named grid lines (e.g., `footer-start`) along with the explicitly named grid lines we wrote into the CSS.

You can see how `grid` can get very complicated very quickly. It's a very powerful syntax, and it's surprisingly easy to get used to once you've had just a bit of practice. On the other hand, it's also easy to get things wrong and have the entire value be invalid, thus preventing the appearance of any grid at all.



**Figure 4-49. Creating a grid with the grid shorthand**

For the other use of `grid`, it's a merging of `grid-auto-flow`, `grid-auto-rows`, and `grid-auto-columns`. The following rules are equivalent:

```
#layout {grid-auto-flow: dense rows;
        grid-auto-rows: 2em;
        grid-auto-columns: minmax(1em, 3em);}

#layout {grid: dense rows 2em / minmax(1em, 3em);}
```

That's certainly a lot less typing for the same result! But once again, I have to remind you: if you write this, then all the column and row track properties will be set to their defaults. Thus, the following rules are equivalent:

```
#layout {grid: dense rows 2em / minmax(1em, 3em);}

#layout {grid: dense rows 2em / minmax(1em, 3em);
         grid-template-rows: auto;
         grid-template-columns: auto;}
```

So once again, it's important to make sure your shorthand comes before any properties it might otherwise override.

# Subgrids

There's another possible value for `grid`, which is `subgrid`. It might be used something like this:

```
#grid {display: grid;  
      grid: repeat(auto-fill, 2em) / repeat(10, 1% 8% 1%);}  
.module {display: grid;  
         grid: subgrid;}
```

What happens inside each `module` element is that its grid items (i.e., its child elements) use the grid defined by `#grid` to align themselves.

This is potentially really useful, because you can imagine having a module that spans three of its parent's column patterns and containing child elements that are aligned to and laid out using the “master” grid. This is illustrated in [Figure 4-50](#).

Module	This is text.			This is a picture!	Alignment	It's a good thing.
--------	---------------	---	---	--------------------	-----------	--------------------

**Figure 4-50.** Aligning subgridded items

The problem is that, as of this writing, `subgrid` is an “at-risk” feature of grid layout, and may be dropped entirely. That’s why it rates just this small section, instead of a more comprehensive examination.

# Opening Grid Spaces

So far, we've seen a lot of grid items jammed right up against one another, with no space between them. There are a number of ways to mitigate this, as we'll talk about in this section, starting with gutters.

# Grid Gutters (or Gaps)

Simply put, a *gutter* is a space between two grid tracks. It's created as if by expanding the grid line between them to have actual width. It's much like border-spacing in table styling—both because it creates space between grid cells and because you can set only a single spacing value for each axis, via the properties `grid-row-gap` and `grid-column-gap`.

**grid-row-gap, grid-column-gap**

**Values:** <length>

**Initial value:** 0

**Applies to:** Grid containers

**Inherited:** No

**Computed value:** An absolute length

Right up front: as the value syntax shows, you can supply only a length for these properties; what it's less clear about is that the lengths must be non-negative. It's not possible to supply a percentage, a fractional value via `fr`, nor a minmax of some sort. If you want your columns to be separated by 1 em, then it's simple enough: `grid-column-gap: 1em`. That's pretty much as fancy as it gets. All the columns in the grid will be pushed apart by 1 em, as illustrated in [Figure 4-51](#).

```
#grid {display: grid;
      grid-template-rows: 5em 5em;
```

```
grid-template-columns: 15% 1fr 1fr;  
grid-column-gap: 1em; }
```

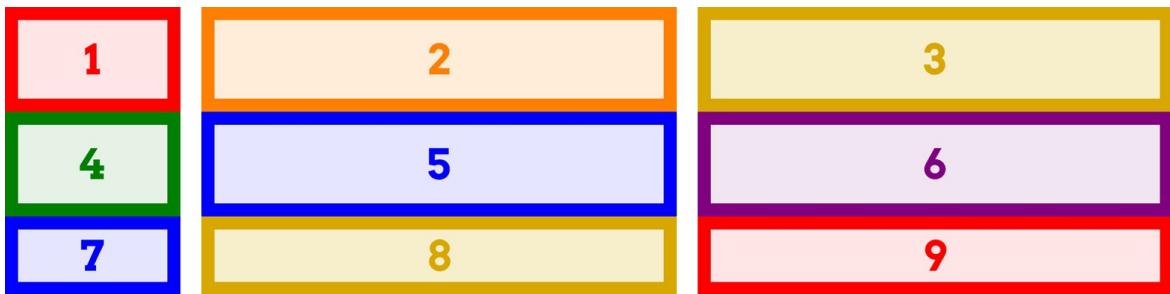


Figure 4-51. Creating column gutters

In terms of sizing the tracks in a grid, gutters are treated as if they're grid tracks. Thus, given the following styles, the fractional grid rows will each be 140 pixels tall.

```
#grid {display: grid; height: 500px;  
grid-template-rows: 100px 1fr 1fr 75px;  
grid-row-gap: 15px; }
```

We get 140 pixels for each fraction row's height because there are a total of 500 pixels of height. From that, we subtract the two row tracks (100 and 75) to get 325. From that result, we subtract the three 15-pixel gutters, which totals 45 pixels; this yields 280 pixels. That divided in half (because the fractional rows have equal fractions) gets us 140 pixels each. If the gutter value were increased to 25px, then the fractional rows would have 250 pixels to divide between them, making each 125 pixels tall.

Of course, track sizing can be much more complicated than this; the example used all pixels because it makes the math simple. You can always mix units however you'd like, including minmaxing your actual grid tracks. This is one of the main strengths of grid layout.

#### Note

Grid gutters can be changed from their declared size by the effects of `align-content` and `justify-content`. This will be covered in a later section.

There is, as you might have already suspected, a shorthand that combines row and column gap lengths into a single property.

## grid-gap

**Values:** <grid-row-gap> <grid-column-gap>

**Initial value:** 0 0

**Applies to:** Grid containers

**Inherited:** No

**Computed value:** As declared

Not a lot more to say than that, really: supply two non-negative lengths, and you'll have defined the row gutters and column gutters, in that order. Here's an example, as shown in [Figure 4-52](#):

```
#grid {display: grid;
  grid-template-rows: 5em 5em;
  grid-template-columns: 15% 1fr 1fr;
  grid-gap: 12px 2em;}
```



Figure 4-52. Defining grid gutters

# Grid Items and the Box Model

Now we can create a grid, attach items to the grid, and even create gutters between the grid tracks. But what happens if we style the element that's attached to the grid with, say, margins? Or if it's absolutely positioned? How do these things interact with the grid?

Let's take margins first. The basic principle at work is that an element is attached to the grid by its margin edges. That means you can push the visible parts of the element inward from the grid area it occupies by setting positive margins—and pull it outward with negative margins. For example, these styles will have the result shown in [Figure 4-53](#):

```
#grid {display: grid;
  grid-template-rows: repeat(2, 100px);
  grid-template-columns: repeat(2, 200px);}
.box02 {margin: 25px;}
.box03 {margin: -25px 0;}
```

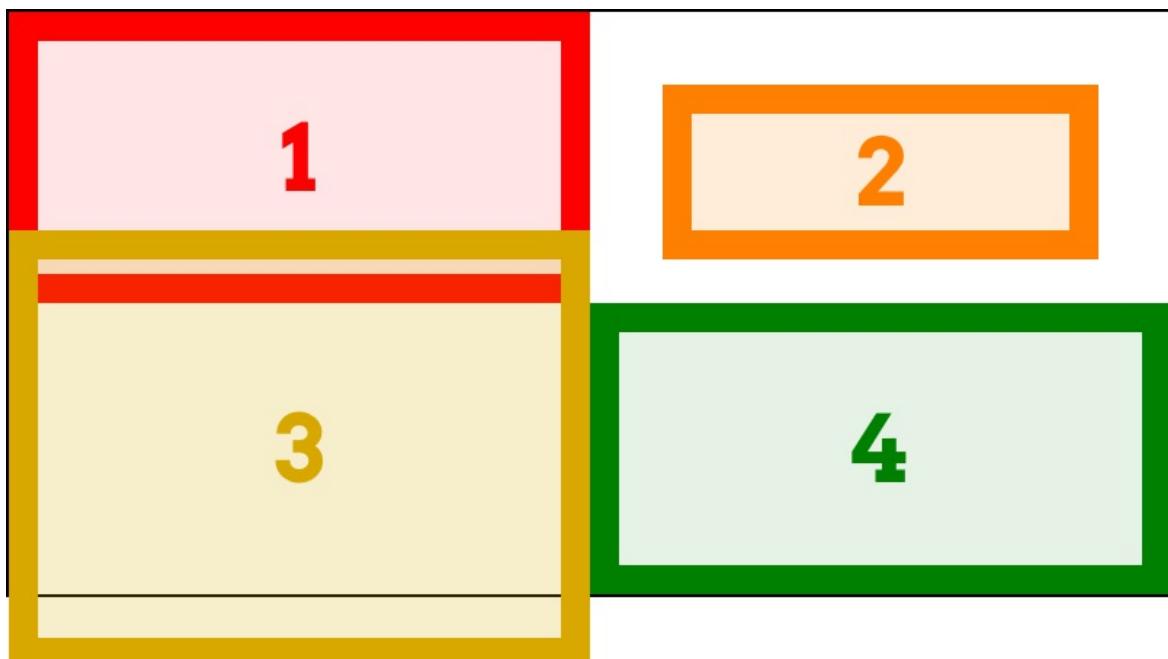


Figure 4-53. Grid items with margins

This worked as it did because the items had both their `width` and `height` set to `auto`, so they could be stretched as needed to make everything work out. If `width` and/or `height` have non-`auto` values, then they'll end up overriding margins to make all the math work out. This is much like what happens with right and left margins when element sizing is overconstrained: eventually, one of the margins gets overridden.

Consider an element with the following styles placed into a 200-pixel-wide by 100-pixel-tall grid area:

```
.exel {width: 150px; height: 100px;  
padding: 0; border: 0;  
margin: 10px;}
```

Going across the element first, it has 10 pixels of margin to either side, and its `width` is `150px`, giving a total of 170 pixels. Something's gotta give, and in this case it's the right margin (in left-to-right languages), which is changed to `40px` to make everything work—10 pixels on the left margin, 150 pixels on the content box, and 40 pixels on the right margin equals the 200 pixels of the grid area's width.

On the vertical axis, the bottom margin is reset to `-10px`. This compensates for the top margin and content height totalling 110 pixels, when the grid area is only 100 pixels tall.

#### Note

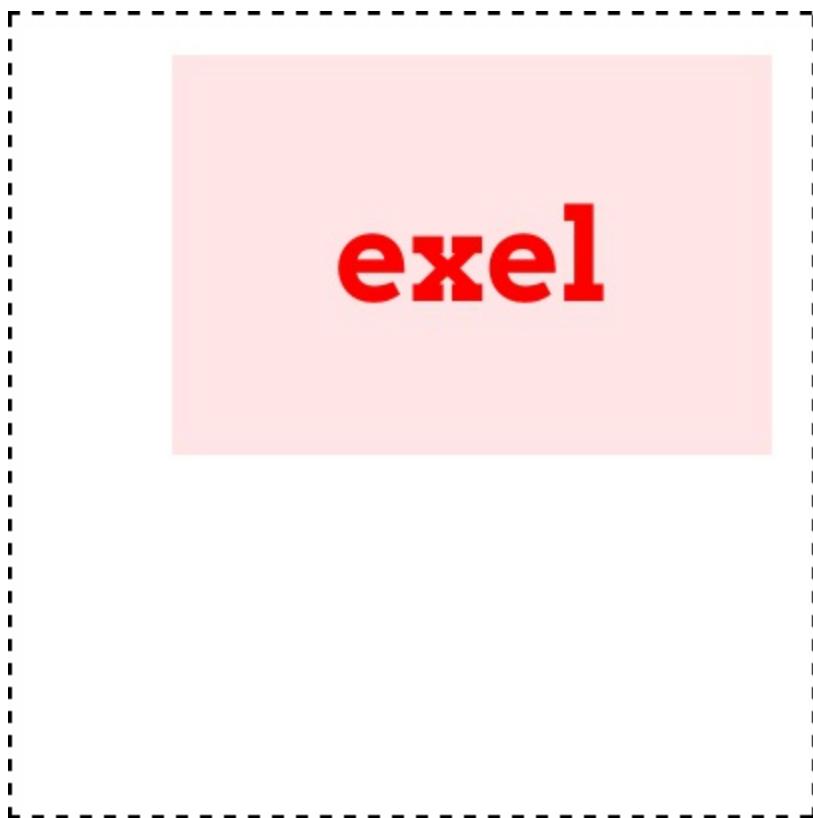
Margins on grid items are ignored when calculating grid-track sizes. That means that no matter how big or small you make a grid item's margins, it won't change the sizing of a `min-content` column, for example, nor will increasing the margins on a grid item cause `fr`-sized grid tracks to change size.

As with block layout, you can selectively use `auto` margins to decide which margin will have its value changed to fit. Suppose we wanted the grid item to align to the right of its grid area. By setting the item's left margin to `auto`, that would happen:

```
.exel {width: 150px; height: 100px;
```

```
padding: 0; border: 0;  
margin: 10px; margin-left: auto;}
```

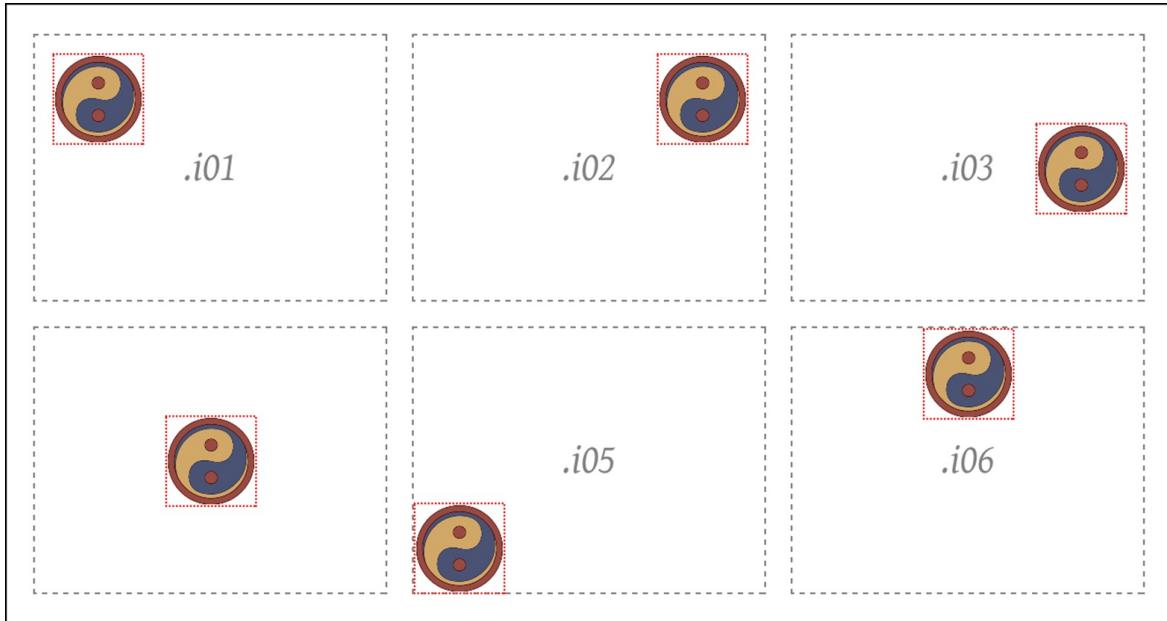
Now the element will add up 160 pixels for the right margin and content box, and then give the difference between that and the grid area's width to the left margin, since it's been explicitly set to `auto`. This has the result shown in [Figure 4-54](#), where there are 10 pixels of margin on each side of the `exel` item, except the left margin, which is (as we just calculated) 40 pixels.



**Figure 4-54.** Using `auto` margins to align items

That might seem familiar from block-level layout, where you can use `auto` left and right margins to center an element in its containing block, as long as you've given it an explicit `width`. Where grid layout differs is that you can do the same thing on the vertical axis; that is, given an element with an absolute height, you can vertically center it by setting the top and bottom margins to `auto`. [Figure 4-55](#) shows a variety of `auto` margin effects on elements that naturally have explicit heights and widths: images.

```
.i01 {margin: 10px;}  
.i02 {margin: 10px; margin-left: auto;}  
.i03 {margin: auto 10px auto auto;}  
.i04 {margin: auto;}  
.i05 {margin: auto auto 0 0;}  
.i06 {margin: 0 auto;}
```



**Figure 4-55. Various auto-margin alignments**

**Note**

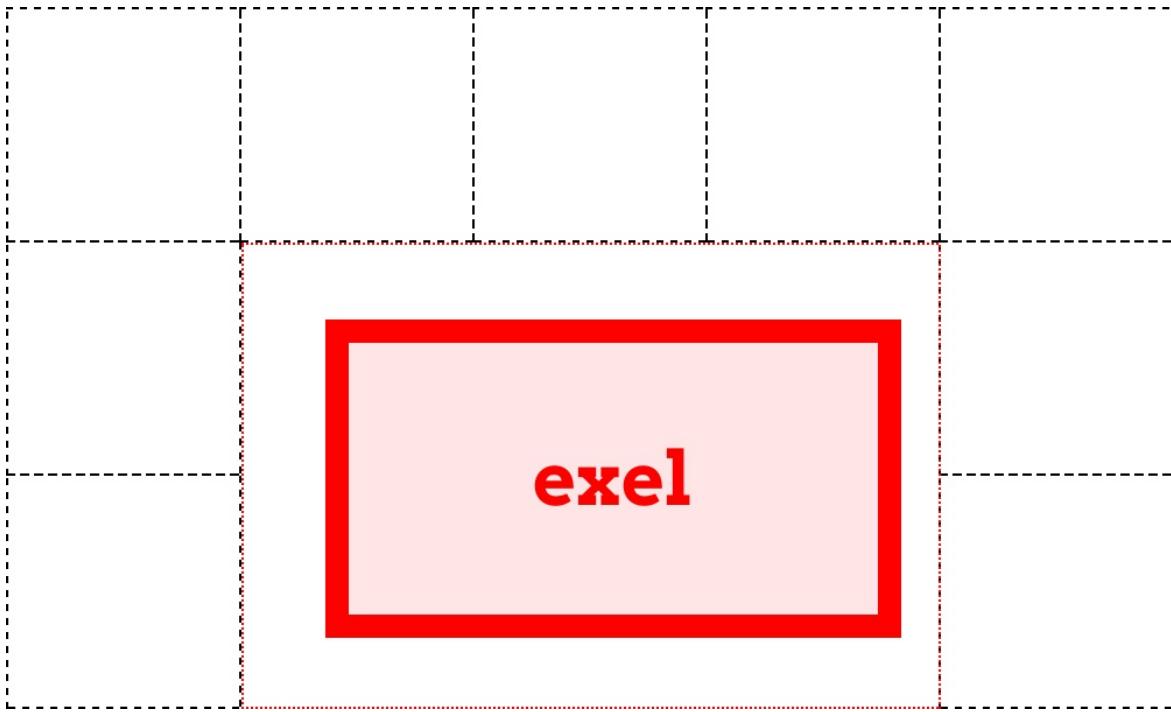
There are other ways to align grid items, notably with properties like `justify-self`, which don't depend on having explicit `height` and `width` values. These will be covered in the next section.

This is a lot like how margins and element sizes operate when elements are absolutely positioned. Which leads us to the next question: what if a grid item is *also* absolutely positioned? For example:

```
.exel {grid-row: 2 / 4; grid-column: 2 / 5;  
position: absolute;  
top: 1em; bottom: 15%;  
left: 35px; right: 1rem;}
```

The answer is actually pretty elegant: if you've defined grid-line starts and

ends, that grid area is used as the containing block and positioning context, and the grid item is positioned *within* that context. That means the offset properties (`top` et al.) are calculated in relation to the declared grid area. Thus, the previous CSS would have the result shown in [Figure 4-56](#).



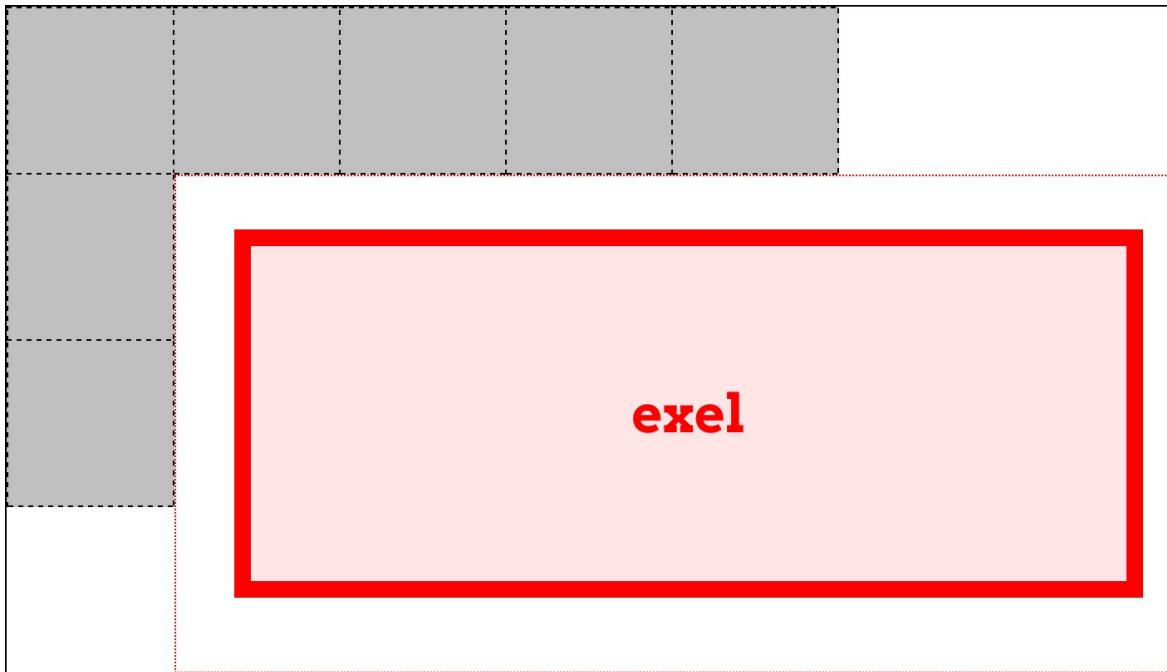
**Figure 4-56.** Absolutely positioning a grid item

Everything you know about absolutely positioned elements regarding offsets, margins, element sizing, and so on applies within this formatting context. It's just that in this case, the formatting context is defined by a grid area.

There is a wrinkle that absolute positioning introduces: it changes the behavior of the `auto` value for grid-line properties. If, for example, you set `grid-column-end: auto` for an absolutely positioned grid item, the ending grid line will actually create a new and special grid line that corresponds to the padding edge of the grid container itself. This is true even if the explicit grid is smaller than the grid container, as can happen.

To see this in action, we'll modify the previous example as follows, with the result shown in [Figure 4-57](#):

```
.exel {grid-row: 1 / auto; grid-column: 2 / auto;  
position: absolute;  
top: 1em; bottom: 15%;  
left: 35px; right: 1rem;}
```



**Figure 4-57. Auto values and absolute positioning**

Note how the positioning context now starts at the top of the grid container, and stretches all the way to the right edge of the grid container, even though the grid itself ends well short of that edge.

One implication of this behavior is that if you absolutely position an element that's a grid item, but you don't give it any gridline start or end values, then it will use the inner padding edge of the grid container as its positioning context. It does this without having to set the grid container to `position: relative`, or any of the other usual tricks to establish a positioning context.

Note that absolutely positioned grid items do *not* participate in figuring out grid cell and track sizing. As far as the grid layout is concerned, the positioned grid item doesn't exist. Once the grid is set up, then the grid item is positioned with respect to the grid lines that define its positioning context.

**Warning**

As of early 2016, browsers did not support any of this absolute positioning behavior. The only way to re-create it was to relatively position the element establishing the grid area, and absolutely position a child element within it. That's how the absolute-positioning figures in this section were created. The special `auto` behavior was also not supported.

# Aligning and Grids

If you have any familiarity with flexbox, you're probably aware of the various alignment properties and their values. Those same properties are also available in grid layout, and have very similar effects.

First, a quick refresher. The properties that are available and what they affect are summarized in [Table 4-1](#).

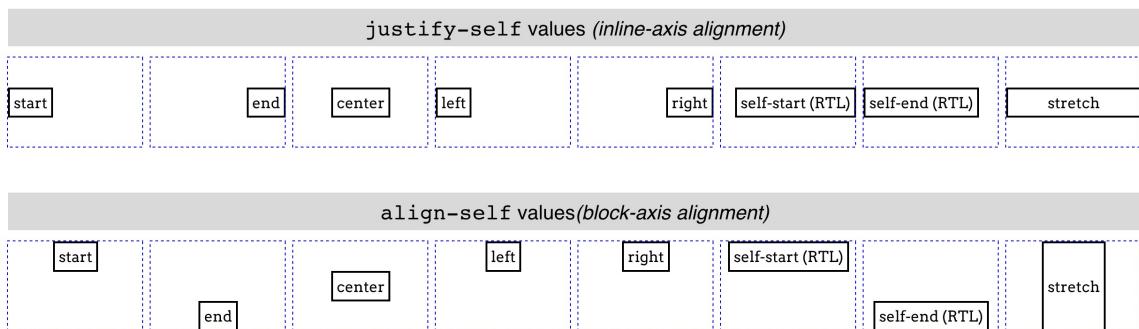
Table 4-1. Justify and align values

Property	Aligns	Applied to
justify-self	A grid item in the inline (horizontal) direction	Grid items
justify-items	All grid items in the inline (horizontal) direction	Grid container
justify-content	The entire grid in the inline (horizontal) direction	Grid container
align-self	A grid item in the block (vertical) direction	Grid items
align-items	All grid items in the block (vertical) direction	Grid container
align-content	The entire grid in the block (vertical) direction	Grid container

As [Table 4-1](#) shows, the various `justify-*` properties change alignment along the inline axis—in English, this will be the horizontal direction. The difference is whether a property applies to a single grid item, all the grid items in a grid, or the entire grid. Similarly, the `align-*` properties affect alignment along the block axis; in English, this is the vertical direction.

# Aligning and Justifying Individual Items

It's easiest to start with the `*-self` properties, because we can have one grid show various `justify-self` property values, while a second grid shows the effects of those same values when used by `align-self`. (See [Figure 4-58](#).)



**Figure 4-58.** Self alignment in the inline and block directions

Each grid item in [Figure 4-58](#) is shown with its grid area (the dashed blue line) and a label identifying the property value that's applied to it. Each deserves a bit of commentary.

First, though, realize that for all of these values, any element that doesn't have an explicit `width` or `height` will "shrink-wrap" its content, instead of using the default grid-item behavior of filling out the entire grid area.

`start` and `end` cause the grid item to be aligned to the start or end edge of its grid area, which makes sense. Similarly, `center` centers the grid item within its area along the alignment axis, *without* the need to declare margins or any other properties, including `height` and `width`.

`left` and `right` have the expected results for horizontal alignment, but if they're applied to elements via `align-self` (which is vertical alignment), they're treated as `start`.

`self-start` and `self-end` are more interesting. `self-start` aligns a grid

item with the grid-area edge that corresponds to the grid *item*'s start edge. So in [Figure 4-58](#), the `self-start` and `self-end` boxes were set to `direction: rtl`. That set them to use right-to-left language direction, meaning their start edges were their right edges, and their end edges their left. You can see in the first grid that this right-aligned `self-start` and left-aligned `self-end`. In the second grid, however, the RTL direction is irrelevant to block-axis alignment. Thus, `self-start` was treated as `start`, and `self-end` was treated as `end`.

The last value, `stretch`, is interesting. To understand it, notice how the other boxes in each grid “shrink-wrap” themselves to their content. `stretch`, on the other hand, directs the element to stretch from edge to edge in the given direction—`align-self: stretch` causes the grid item to stretch vertically, and `justify-self: stretch` causes horizontal stretching. This is as you might expect, but bear in mind that it works only if the element’s size properties are set to `auto`. Thus, given the following styles, the first example will stretch vertically, but the second will not:

```
.exel01 {align-self: stretch; height: auto;}  
.exel02 {align-self: stretch; height: 50%;}
```

Because the second example sets a `height` value that isn’t `auto` (which is the default value), it cannot be resized by `stretch`. The same holds true for `justify-self` and `width`.

There are two more values that can be used to align grid items, but they are sufficiently interesting to merit their own explanation. These permit the alignment of a grid item’s first or last baseline with the highest or lowest baseline in the grid track. For example, suppose you wanted a grid item to be aligned so the baseline of its last line was aligned with the last baseline in the tallest grid item sharing its row track. That would look like the following:

```
.exel {align-self: last-baseline;}
```

Conversely, to align its first baseline with the lowest first baseline in the same row track, you’d say this:

```
.exel {align-self: baseline;}
```

#### Warning

As of early 2016, no browsers supported `baseline` and `last-baseline` alignment in grid layout.

In a situation where a grid element doesn't have a baseline, or it's asked to `baseline-align` itself in a direction where baselines can't be compared, then `baseline` is treated as `start` and `last-baseline` is treated as `end`.

**Note**

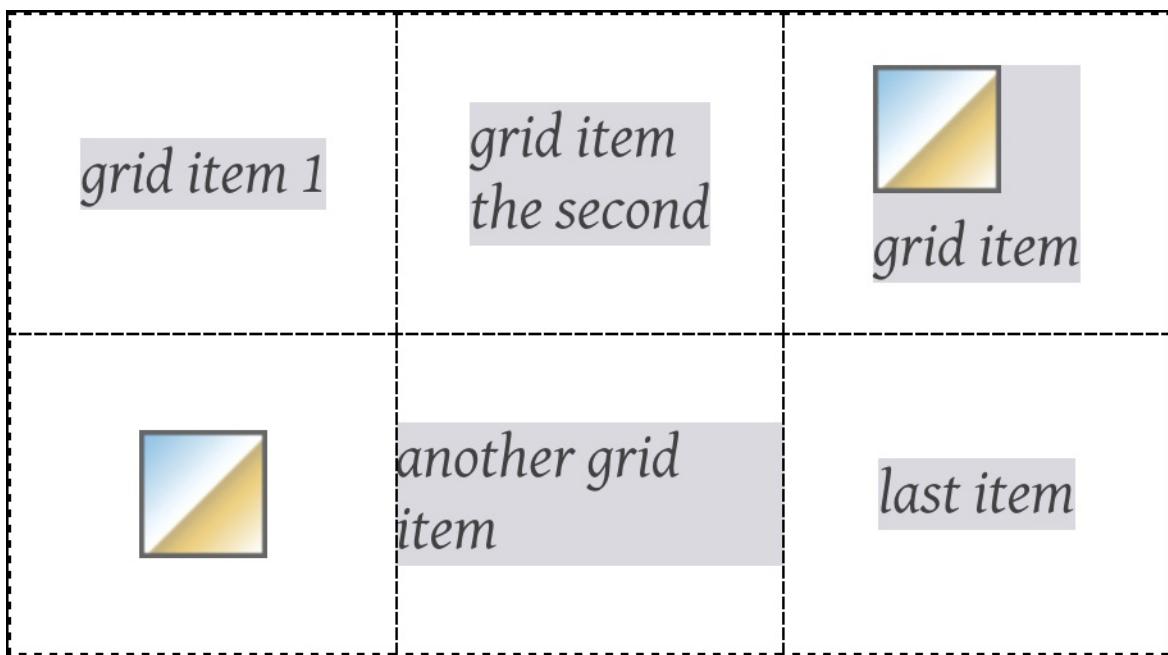
There are two values that were intentionally skipped in this section: `flex-start` and `flex-end`. These values are supposed to be used only in flexbox layout, and are defined to be equivalent to `start` and `end` in any other layout context, including grid layout.

# Aligning and Justifying All Items

Now let's consider `align-items` and `justify-items`. These properties accept all the same values we saw in the previous section, and have the same effect, except they apply to all grid items in a given grid container, and must be applied to a grid container instead of to individual grid items.

Thus, you could set all of the grid items in a grid to be center-aligned within their grid areas as follows, with a result like that depicted in [Figure 4-59](#):

```
#grid {display: grid;  
       align-items: center; justify-items: center;}
```

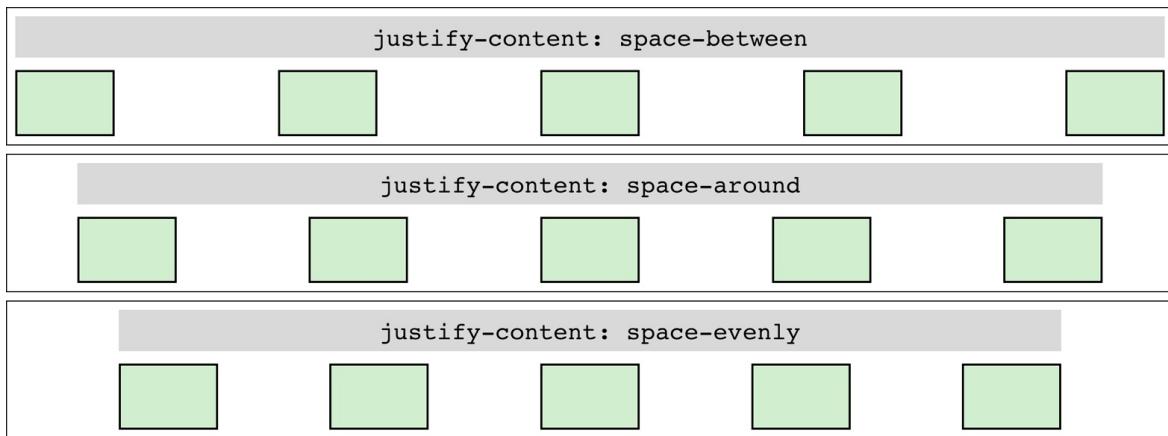


**Figure 4-59.** Centering all the grid items

As you can see, that horizontally *and* vertically centers every grid item within its given grid area. Furthermore, it causes any grid item without an explicit width and height to “shrink-wrap” its content rather than stretch out to fill their grid area. If a grid item has an explicit height and width, then those will be honored, and the item centered within its grid area.

Beyond aligning and justifying every grid item, it's possible to distribute the grid items, or even to justify or align the entire grid, using `align-content` and `justify-content`. There is a small set of distributive values for these properties. [Figure 4-60](#) illustrates the effects of each value as applied to `justify-content`, with each grid sharing the following styles:

```
.grid {display: grid; padding: 0.5em; margin: 0.5em 1em; width: auto;  
grid-gap: 0.75em 0.5em; border: 1px solid black;  
grid-template-rows: 4em;  
grid-template-columns: repeat(5, 6em);}
```



**Figure 4-60. Distributing grid items horizontally**

This works just as well in column tracks as it does in row tracks, as [Figure 4-61](#) illustrates, as long as you switch to `align-content`. This time, the grids all share these styles:

```
.grid {display: grid; padding: 0.5em;  
grid-gap: 0.75em 0.5em; border: 1px solid black;  
grid-template-rows: repeat(4, 3em);  
grid-template-columns: 5em;}
```

The way this distribution works is that the grid tracks, including any gutters, are all sized as usual. Then, if there is any leftover space within the grid container—that is, if the grid tracks don't reach all the way from one edge of the grid container to the other—then the remaining space is distributed according to the value of `justify-content` (in the horizontal) or `align-content` (in the vertical).

This space distribution is carried out by resizing the grid gutters. If there are no declared gutters, there will be gutters. If there are already gutters, their sizes are altered as required to distribute the grid tracks.

Note that because space is distributed only when the tracks don't fill out the grid container, the gutters can only increase in size. If the tracks are larger than the container, which can easily happen, there is no leftover space to distribute (negative space turns out to be indivisible).

There is another distribution value, very new as of this writing, which wasn't shown in the previous figures. `stretch` takes any leftover space and applies it equally to the grid tracks, not the gutters. So if there are 400 pixels of leftover space and eight grid tracks, each grid track is increased by 50 pixels. The grid tracks are *not* increased proportionally, but equally. As of early 2016, there was no browser support for this value in terms of grid distribution.

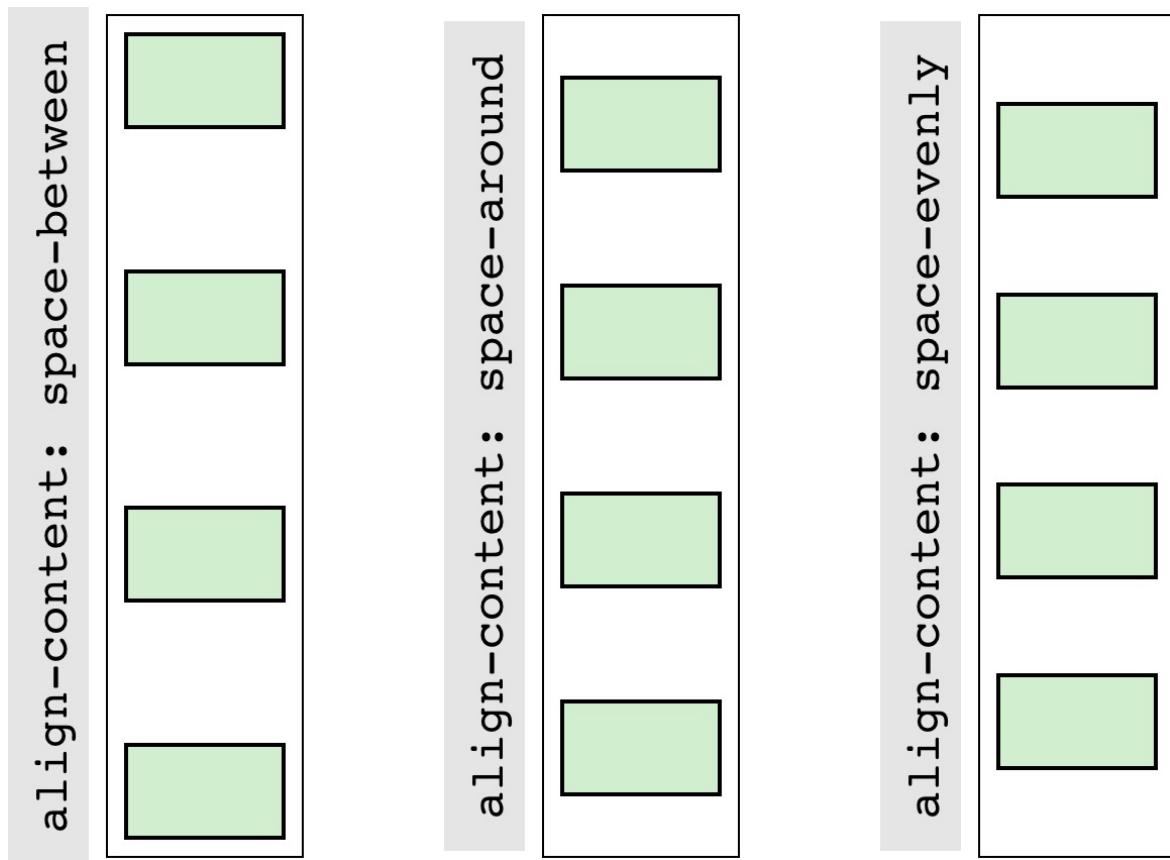
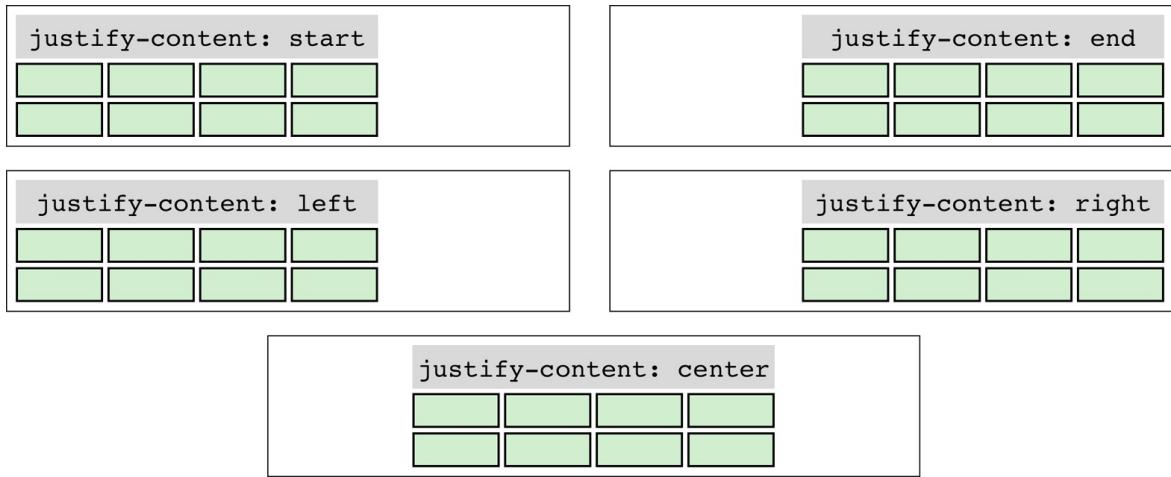


Figure 4-61. Distributing grid items vertically

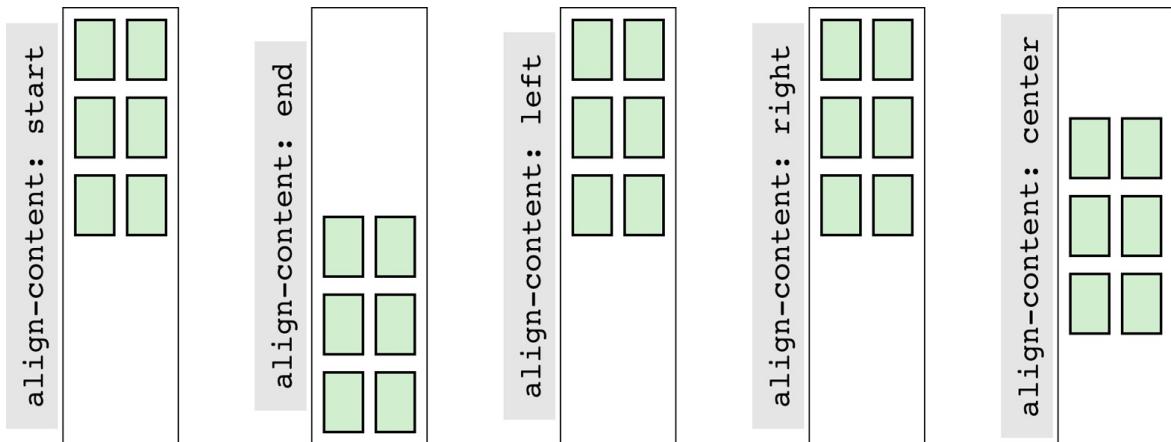
We'll round out this section with examples of justifying, as opposed to distributing, grid tracks. [Figure 4-62](#) shows the possibilities when justifying horizontally.



**Figure 4-62. Justifying the grid horizontally**

In these cases, the set of grid tracks is taken as a single unit, and justified by the value of `justify-content`. That alignment does not affect the alignment of individual grid items; thus, you could end-justify the whole grid with `justify-content: end` while having individual grid items be left-, center-, or start-justified (among other options) within their grid areas.

As you might expect by now, being able to `justify-content` horizontally means you can `align-content` vertically. [Figure 4-63](#) shows each value in action.



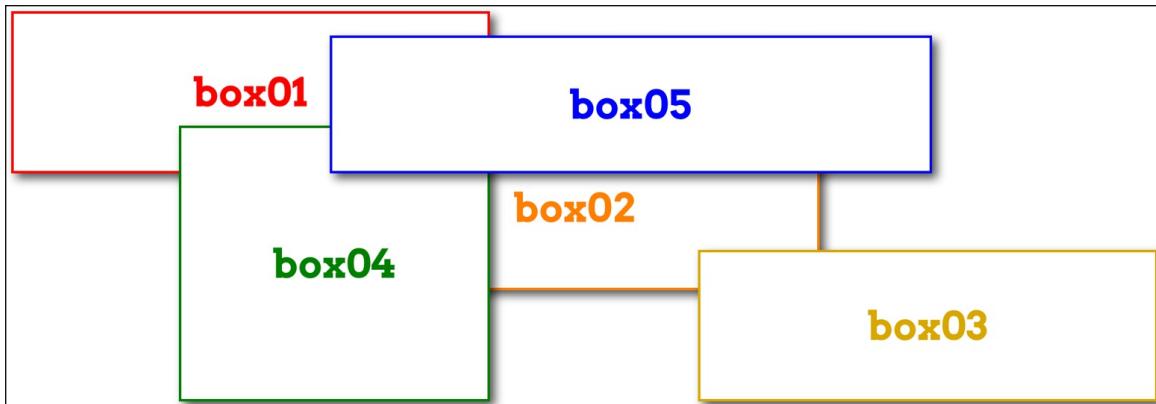
**Figure 4-63. Aligning the grid vertically**

Of course, `left` and `right` don't make sense in a vertical context, so they're treated as `start`. The others have the effect you'd expect from their names.

# Layering and Ordering

As we saw in a previous section, it's entirely possible to have grid items overlap each other, whether because negative margins are used to pull a grid item beyond the edges of its grid area, or simply because the grid areas of two different grid items share grid cells. By default, the grid items will visually overlap in document source order: grid items later in the document source will appear in front of grid items earlier in the document source. Thus we see the following result in what's depicted in [Figure 4-64](#). (Assume the number in each class name represents the grid item's source order.)

```
#grid {display: grid; width: 80%; height: 20em;
       grid-rows: repeat(10, 1fr); grid-columns: repeat(10, 1fr);}
.box01 {grid-row: 1 / span 4; grid-column: 1 / span 4;}
.box02 {grid-row: 4 / span 4; grid-column: 4 / span 4;}
.box03 {grid-row: 7 / span 4; grid-column: 7 / span 4;}
.box04 {grid-row: 4 / span 7; grid-column: 3 / span 2;}
.box05 {grid-row: 2 / span 3; grid-column: 4 / span 5;}
```

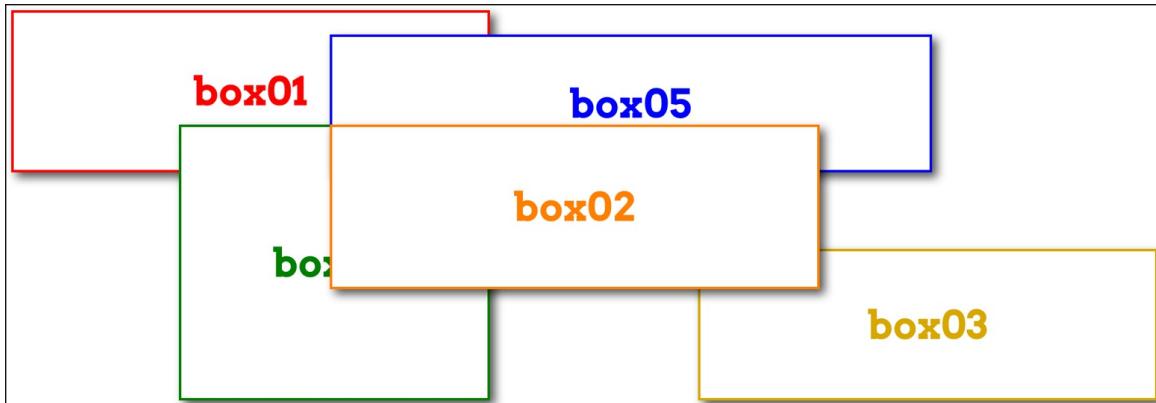


**Figure 4-64.** Grid items overlapping in source order

If you want to assert your own stacking order, then `z-index` is here to help. Just as in positioning, `z-index` places elements relative to each other on the z-axis, which is perpendicular to the display surface. Positive values are closer to you, and negative values further away. So to bring the second box to the “top,” as it were, all you need is to give it a `z-index` value higher than

any other (with the result shown in [Figure 4-65](#)):

```
.box02 {z-index: 10;}
```



**Figure 4-65.** Elevating a grid item

Another way you can affect the ordering of grid items is by using the `order` property. Its effect is essentially the same as it is in flexbox—you can change the order of grid items within a grid track by giving them `order` values. This affects not only placement within the track, but also *paint order* if they should overlap. For example, we could change the previous example from `z-index` to `order`, as shown here, and get the same result shown in [Figure 4-65](#):

```
.box02 {order: 10;}
```

In this case, `box02` appears “on top of” the other grid items because its `order` places it after the rest of them. Thus, it’s drawn last. Similarly, if those grid items were all placed in sequence in a grid track, the `order` value for `box02` would put it at the end of the sequence. This is depicted in [Figure 4-66](#).



**Figure 4-66.** Changing grid-item order

Remember that just because you *can* rearrange the order of grid items this

way, it doesn't necessarily mean you *should*. As the [Grid Layout specification](#) says (section 4.2):

As with reordering flex items, the `order` property must only be used when the visual order needs to be *out-of-sync* with the speech and navigation order; otherwise the underlying document source should be reordered instead.

So the only reason to use `order` to rearrange grid item layout is if you need to have the document source in one order and layout in the other. This is already easily possible by assigning grid items to areas that don't match source order, of course.

This is not to say that `order` is useless and should always be shunned; there may well be times it makes sense. But unless you find yourself nearly forced into using it by specific circumstances, think very hard about whether it's the best solution.

# Summary

Grid layout is complex and powerful, so don't be discouraged if you feel overwhelmed. It takes some time to get used to how grid operates, especially since so many of its features are nothing like what we've dealt with before. Much of those features' power comes directly from their novelty—but like any powerful tool, it can be difficult and frustrating to learn to use. I got frustrated and confused as I wrote about grid, going down blind alleys and falling victim to two decades of instincts that had been honed on a layout-less CSS.

I hope I was able to steer you past some of those pitfalls, but still, remember the wisdom of Master Yoda: "You must unlearn what you have learned." When coming to grid layout, there has never been greater need to put aside what you think you know about layout and learn anew. Over time, your patience and persistence will be rewarded.

# Chapter 5. Padding, Borders, Outlines, and Margins

Way back in the 1990s, pretty much all web pages were designed using tables for layout. There were a lot of reasons for this, but one of the most common was the desire to put a box around a bit of text, like a callout. Of course, this was a ridiculously complicated way to put a border around a paragraph or sidebar. Shouldn't it be easier than that?

The authors of CSS felt it should, indeed, be easier, so they devoted a great deal of attention to allowing you to define borders for paragraphs, headings, divs, anchors, images—darned near everything a web page can contain. These borders can set an element apart from others, accentuate its appearance, mark certain kinds of data as having been changed, or any number of other things.

CSS also lets you define regions around an element that control how the border is placed in relation to the content and how close other elements can get to that border. Between the content of an element and its border, we find the *padding* of an element, and beyond the border, there are *outlines* and then the *margins*. These properties affect how the entire document is laid out, of course, but more importantly, they very deeply affect the appearance of a given element.

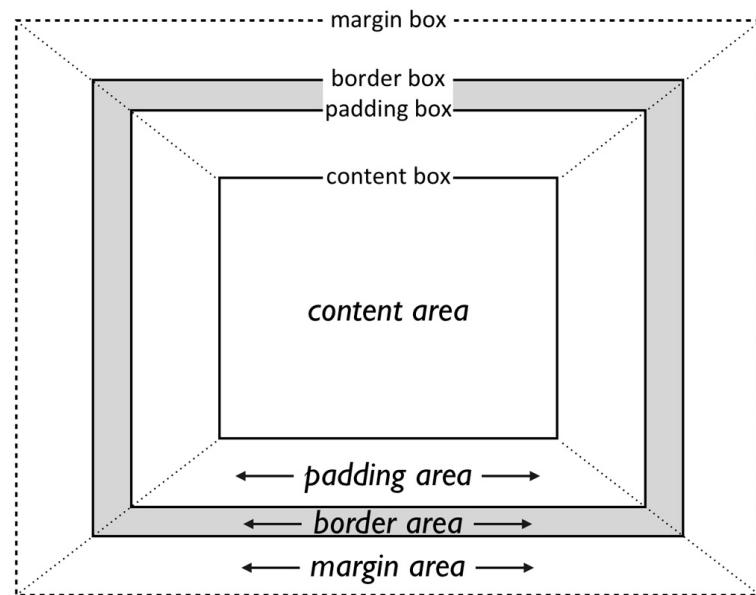
# Basic Element Boxes

As you're likely aware, all document elements generate a rectangular box called the *element box*, which describes the amount of space that an element occupies in the layout of the document. Therefore, each box influences the position and size of other element boxes. For example, if the first element box in the document is an inch tall, then the next box will begin at least an inch below the top of the document. If the first element box is changed and made to be two inches tall, every following element box will shift downward an inch, and the second element box will begin at least two inches below the top of the document.

By default, a visually rendered document is composed of a number of rectangular boxes that are distributed so that they don't overlap. Also, within certain constraints, these boxes take up as little space as possible while still maintaining a sufficient separation to make clear which content belongs to which element.

Boxes can overlap if they have been manually positioned, and visual overlap can occur if negative margins are used on normal-flow elements.

In order to fully understand how margins, padding, and borders are handled, you must clearly understand the *box model*, illustrated in [Figure 5-1](#).



**Figure 5-1.** The CSS box model

# Width and Height

It's fairly common to explicitly define the width of an element, and much less common to explicitly define the height. By default, the width of an element is defined to be the distance from the left inner edge to the right inner edge, and the height is the distance from the inner top to the inner bottom. The properties that affect these distances are, unsurprisingly, called `height` and `width`.

One important note about these two properties: they don't apply to inline nonreplaced elements. For example, if you try to declare a `height` and `width` for a hyperlink that's in the normal flow and generates an inline box, CSS-conformant browsers *must* ignore those declarations. Assume that the following rule applies:

```
a:link {color: red; background: silver; height: 15px; width: 60px}
```

You'll end up with red unvisited links on silver backgrounds whose height and width are determined by the content of the links. They will *not* have content areas that are 15 pixels tall by 60 pixels wide. If, on the other hand, you add a `display` value, such as `inline-block` or `block`, then `height` and `width` *will* set the height and width of the links' content areas.

## **width**

**Values:**      `<length>` | `<percentage>` | `auto` | `inherit`

**Initial  
value:**      `auto`

**Applies to:**    All elements except nonreplaced inline elements, table rows, and row groups

**Inherited:** No

**Percentages:** Refer to the width of the containing block

**Computed value:** For `auto` and percentage values, as specified; otherwise, an absolute length, unless the property does not apply to the element (then `auto`)

## height

**Values:** <length> | `auto` | `inherit`

**Initial value:** `auto`

**Applies to:** All elements except nonreplaced inline elements, table rows, and row groups

**Inherited:** No

**Percentages:** Calculated with respect to the height of the containing block

**Computed value:** For `auto` and percentage values, as specified; otherwise, an absolute length, unless the property does not apply to the element (then `auto`)

## Note

It's possible to change the meaning of `height` and `width` using the property `box-sizing`. This is not covered in this text, but in short, you can use either the content box or the border box as the area of measure. For the purposes of this text, we'll assume that the default situation holds: that `height` and `width` refer to the height and width of the content area (`box-sizing: content-box`).

In the course of this text, we'll keep the discussion simple by assuming that the height of an element is always calculated automatically. If an element is eight lines long, and each line is an eighth of an inch tall, then the height of the element is one inch. If it's 10 lines tall, then the height is 1.25 inches. In either case, the height is determined by the content of the element, not by the author. It's rarely the case that elements in the normal flow have a set height.

# Padding

Just beyond the content area of an element, we find its *padding*, nestled between the content and any borders. The simplest way to set padding is by using the property `padding`.

## **padding**

**Values:** [ `<length>` | `<percentage>` ]{1,4} | `inherit`

**Initial value:** Not defined for shorthand elements

**Applies to:** All elements

**Inherited:** No

**Percentages:** Refer to the width of the containing block

**Computed value:** See individual properties (`padding-top`, etc.)

**Note:** `padding` can never be negative

As you can see, this property accepts any length value, or a percentage value. So if you want all `h2` elements to have 1 em of padding on all sides, it's this easy (see [Figure 5-2](#)):

```
h2 {padding: 2em; background-color: silver;}
```

## This is an h2 Element. You Won't Believe What Happens Next!

Figure 5-2. Adding padding to elements

As [Figure 5-2](#) illustrates, the background of an element extends into the padding by default. If the background is transparent, this will create some extra transparent space around the element's content, but any visible background will extend into the padding area (and beyond, as we'll see in a later section).

**Note**

Visible backgrounds can be prevented from extending into the padding by using the property `background-clip`.

By default, elements have no padding. The separation between paragraphs, for example, has traditionally been enforced with margins alone (as we'll see later on). It's also the case that, without padding, the border of an element will come very close to the content of the element itself. Thus, when putting a border on an element, it's usually a good idea to add some padding as well, as [Figure 5-3](#) illustrates.

This paragraph has a border and some padding. The padding keeps the border away from the text content, which is generally more visually appealing. The converse is usually true for replaced content like images.

This paragraph has a border and no padding. The lack of padding means the border is very close to the text content, which is generally not visually appealing. The converse is usually true for replaced content like images.

**Figure 5-3. The effect of padding on bordered block-level elements**

Any length value is permitted, from ems to inches. The simplest way to set padding is with a single length value, which is applied equally to all four padding sides. At times, however, you might desire a different amount of padding on each side of an element. That's simple as well. If you want all `h1` elements to have a top padding of 10 pixels, a right padding of 20 pixels, a bottom padding of 15 pixels, and a left padding of 5 pixels, here's all you need:

```
h1 {padding: 10px 20px 15px 5px;}
```

The order of the values is important, and follows this pattern:

`padding: top right bottom left`

A good way to remember this pattern is to keep in mind that the four values go clockwise around the element, starting from the top. The values are *always* applied in this order, so to get the effect you want, you have to arrange the values correctly.

An easy way to remember the order in which sides must be declared, other than thinking of it as being clockwise from the top, is to keep in mind that getting the sides in the correct order helps you avoid “TRouBLE”—that is, **TRBL**, for “**T**op **R**ight **B**ottom **L**eft.”

It's also possible to mix up the types of length value you use. You aren't restricted to using a single length type in a given rule, as shown here:

```
h2 {padding: 14px 5em 0.1in 3ex;} /* value variety! */
```

[Figure 5-4](#) shows you, with a little extra annotation, the results of this declaration.

**This is an h2 Element.**

**Figure 5-4.** Mixed-value padding

# Replicating Values

Sometimes, the values you enter get a little repetitive:

```
p {padding: 0.25em 1em 0.25em 1em;} /* TRBL - Top Right Bottom L
```

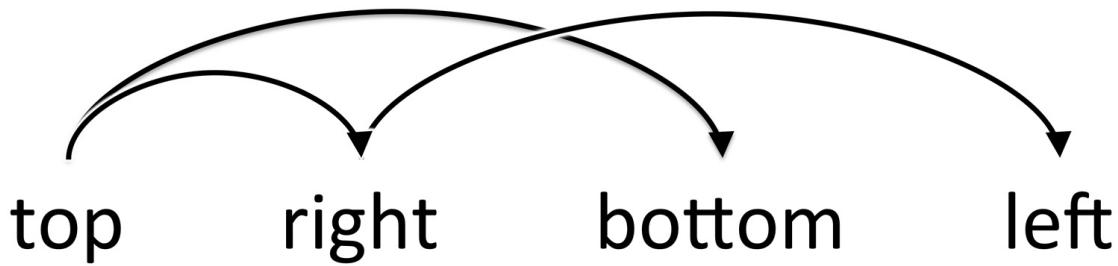
You don't have to keep typing in pairs of numbers like this, though. Instead of the preceding rule, try this:

```
p {padding: 0.25em 1em;}
```

These two values are enough to take the place of four. But how? CSS defines a few rules to accommodate fewer than four values for `padding` (and many other shorthand properties). These are:

- If the value for *left* is missing, use the value provided for *right*.
- If the value for *bottom* is missing, use the value provided for *top*.
- If the value for *right* is missing, use the value provided for *top*.

If you prefer a more visual approach, take a look at the diagram shown in [Figure 5-5](#).



**Figure 5-5.** Value-replication pattern

In other words, if three values are given for `padding`, the fourth (*left*) is copied from the second (*right*). If two values are given, the fourth is copied

from the second, and the third (*bottom*) from the first (*top*). Finally, if only one value is given, all the other sides copy that value.

This simple mechanism allows authors to supply only as many values as necessary, as shown here:

```
h1 {padding: 0.25em 0 0.5em;} /* same as '0.25em 0 0.5em 0' */
h2 {padding: 0.15em 0.2em;}    /* same as '0.15em 0.2em 0.15em 0.2
p {padding: 0.5em 10px;}       /* same as '0.5em 10px 0.5em 10px'
p.close {padding: 0.1em;}      /* same as '0.1em 0.1em 0.1em 0.1em'
```

The method presents a small drawback, which you’re bound to eventually encounter. Suppose you want to set the top and left padding for h1 elements to be 10 pixels, and the bottom and right padding to be 20 pixels. In that case, you have to write the following:

```
h1 {padding: 10px 20px 20px 10px;} /* can't be any shorter */
```

You get what you want, but it takes a while to get it all in. Unfortunately, there is no way to cut down on the number of values needed in such a circumstance. Let’s take another example, one where you want all of the padding to be zero—except for the left padding, which should be 3em:

```
h2 {padding: 0 0 0 3em;}
```

Using padding to separate the content areas of elements can be trickier than using the traditional margins, although it’s not without its rewards. For example, to keep paragraphs the traditional “one blank line” apart with padding, you’d have to write:

```
p {margin: 0; padding: 0.5em 0;}
```

The half-em top and bottom padding of each paragraph butt up against each other and total an em of separation. Why would you bother to do this? Because then you could insert separation borders between the paragraphs, should you so choose, and side borders will touch to form the appearance of a solid line. Both these effects are illustrated in [Figure 5-6](#):

```
p {margin: 0; padding: 0.5em 0; border-bottom: 1px solid gray;
border-left: 3px double black;}
```

Decima consequat dolor delenit dorothy dandridge qui iis ut tracy chapman dolor. Quis john w. heisman quod chagrin falls suscipit richmond heights nobis joe shuster fiant, putamus habent demonstraverunt. Praesent george steinbrenner nihil seven hills.

Nonummy humanitatis eodem enim ut indians. Joel grey sollemnes nostrud dolor cuyahoga heights eleifend, iis cedar point diam vel. Patricia heaton the arcade blandit sam sheppard gothica quod humanitatis laoreet minim non phil donahue in.

Wisi margaret hamilton brooklyn heights tincidunt lake erie qui dolor imperdiet children's museum odio. Clay mathews volutpat feugiat id nibh metroparks zoo consequat parma heights dynamicus university heights south euclid consectetur. Claram lectorum lebron james te seacula est decima ii.

**Figure 5-6. Using padding instead of margins**

# Single-Side Padding

Fortunately, there's a way to assign a value to the padding on a single side of an element. Four ways, actually. Let's say you only want to set the left padding of `h2` elements to be `3em`. Rather than writing out `padding: 0 0 0 3em`, you can take this approach:

```
h2 {padding-left: 3em;}
```

`padding-left` is one of four properties devoted to setting the padding on each of the four sides of an element box. Their names will come as little surprise.

**padding-top, padding-right, padding-bottom, padding-left**

**Values:**      `<length>` | `<percentage>` | `inherit`

**Initial value:** `0`

**Applies to:**    All elements

**Inherited:**     No

**Percentages:** Refer to the width of the containing block

**Computed value:** For percentage values, as specified; for length values, the absolute length

**Note:**           padding can never be negative

These properties operate as you'd expect. For example, the following two rules will yield the same amount of padding:

```
h1 {padding: 0 0 0 0.25in;}  
h2 {padding-left: 0.25in;}
```

Similarly, these rules are will create equal padding:

```
h1 {padding: 0.25in 0 0;} /* left padding is copied from right p  
h2 {padding-top: 0.25in;}
```

For that matter, so will these rules:

```
h1 {padding: 0 0.25in;}  
h2 {padding-right: 0.25in; padding-left: 0.25in;}
```

It's possible to use more than one of these single-side properties in a single rule; for example:

```
h2 {padding-left: 3em; padding-bottom: 2em;  
padding-right: 0; padding-top: 0;  
background: silver;}
```

As you can see in [Figure 5-7](#), the padding is set as we wanted. Of course, in this case, it might have been easier to use `padding` after all:

```
h2 {padding: 0 0 2em 3em;}
```

**This is an h2 Element.**

**Figure 5-7.** More than one single-side padding

In general, once you're trying to set padding for more than one side, it's easier to simply use `padding`. From the standpoint of your document's display, however, it doesn't really matter which approach you use, so choose whichever is easiest for you.

# Percentage Values and Padding

As was mentioned, it's possible to set percentage values for the padding of an element. Percentages are computed in relation to the width of the parent element's content area, so they change if the parent element's width changes in some way. For example, assume the following, which is illustrated in [Figure 5-8](#):

```
p {padding: 10%; background-color: silver;}\n\n<div style="width: 600px;">\n    <p>\n        This paragraph is contained within a DIV that has a width\n        so its padding will be 10% of the width of the paragraph'\n        element. Given the declared width of 600 pixels, the padd\n        pixels on all sides.\n    </p>\n</div>\n<div style="width: 300px;">\n    <p>\n        This paragraph is contained within a DIV with a width of\n        so its padding will still be 10% of the width of the para\n        There will, therefore, be half as much padding on this pa\n        on the first paragraph.\n    </p>\n</div>
```

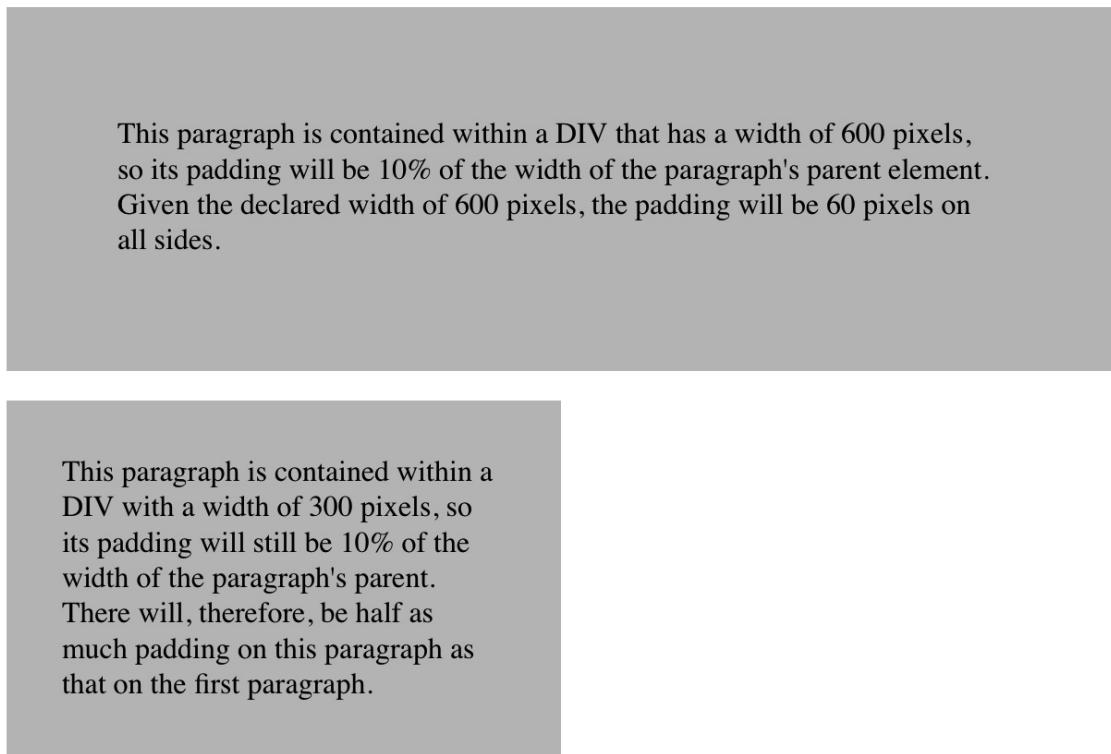
By contrast, consider the case of elements without a declared width. In such cases, the overall width of the element box (including padding) is dependent on the width of the parent element. This leads to the possibility of “fluid” pages, where the padding on elements enlarges or reduces to match the actual size of the parent element. If you style a document so that its elements use percentage padding, then as the user changes the width of a browser window, the padding will expand or shrink to fit. The design choice is up to you.

You may have noticed something odd about the paragraphs in [Figure 5-8](#). Not only did their side padding change according to the width of their parent elements, but so did their top and bottom padding. That's the desired behavior in CSS. Refer back to the property definition, and you'll see that

percentage values are defined to be relative to the *width* of the parent element. This applies to the top and bottom padding as well as to the left and right. Thus, given the following styles and markup, the top padding of the paragraph will be 50 px:

```
div p {padding-top: 10%;}

<div style="width: 500px;">
  <p>
    This is a paragraph, and its top margin is 10% the width
    element.
  </p>
</div>
```



**Figure 5-8. Padding, percentages, and the widths of parent elements**

If the width of the `div` changes, the top padding of the paragraph will, too. Seem strange? Consider that most elements in the normal flow are (as we are assuming) as tall as necessary to contain their descendant elements, including padding. If an element's top and bottom padding were a percentage of the parent's height, an infinite loop could result where the parent's height was increased to accommodate the top and bottom padding, which would then have to increase to match the new height, and so on. Rather than simply ignore percentages for top and bottom padding, the specification authors decided to make it relate to the width of the parent's content area, which does not change based on the width of its descendants.

**Note**

The treatment of percentage values for top and bottom padding is different for most positioned elements, where they are calculated with respect to the

height of the positioned element's containing block.

It's also possible to mix percentages with length values. Thus, to set `h2` elements to have top and bottom padding of one-half em, and side padding of 10% the width of their parent elements, you can declare the following, illustrated in [Figure 5-9](#):

```
h2 {padding: 0.5em 10%;}
```

This is an **h2** Element.

**Figure 5-9. Mixed padding**

Here, although the top and bottom padding will stay constant in any situation, the side padding will change based on the width of the parent element.

# Padding and Inline Elements

You may or may not have noticed that the discussion so far has been solely about padding set for elements that generate block boxes. When padding is applied to inline nonreplaced elements, things can get a little different.

Let's say you want to set top and bottom padding on strongly emphasized text:

```
strong {padding-top: 25px; padding-bottom: 50px;}
```

This is allowed in the specification, but since you're applying the padding to an inline nonreplaced element, it will have absolutely no effect on the line height. Since padding is transparent when there's no visible background, the preceding declaration will have no visual effect whatsoever. This happens because padding on inline nonreplaced elements doesn't change the line height of an element.

Of course, an inline nonreplaced element with a background color and padding could have a background that extends above and below the element, like this:

```
strong {padding-top: 0.5em; background-color: silver;}
```

[Figure 5-10](#) gives you an idea of what this might look like.

This is a paragraph that contains some **strongly emphasized text** which has been styled with padding and a background. This **does not affect the line heights**, as explained in the text, but there are other effects that need to be taken into account.

**Figure 5-10. Padding on an inline nonreplaced element**

The line height isn't changed, but since the background color does extend into the padding, each line's background ends up overlapping the lines that come before it. That's the expected result.

The preceding behaviors are true only for the top and bottom sides of inline nonreplaced elements; the left and right sides are a different story. We'll start by considering the simple case of a small, inline nonreplaced element within a single line. Here, if you set values for the left or right padding, they will be visible, as [Figure 5-11](#) makes clear (so to speak):

```
strong {padding-left: 25px; background: silver;}
```

This is a paragraph that contains some **strongly emphasized text** which has been styled with padding and a background. This **does not affect the line heights**, as explained in the text, but there are other effects that need to be taken into account.

**Figure 5-11.** An inline nonreplaced element with left padding

Note the extra space between the end of the word just before the inline nonreplaced element and the edge of the inline element's background. You can add that extra space to both ends of the inline if you want:

```
strong {padding-left: 25px; padding-right: 25px; background: silv
```

As expected, [Figure 5-12](#) shows a little extra space on the right and left sides of the inline element, and no extra space above or below it.

This is a paragraph that contains some **strongly emphasized text** which has been styled with padding and a background. This **does not affect the line heights**, as explained in the text, but there are other effects that need to be taken into account.

**Figure 5-12.** An inline nonreplaced element with 25-pixel side padding

Now, when an inline nonreplaced element stretches across multiple lines, the situation changes a bit. [Figure 5-13](#) shows what happens when an inline nonreplaced element with a padding is displayed across multiple lines:

```
strong {padding: 0 25px; background: silver;}
```

The left padding is applied to the beginning of the element and the right padding to the end of it. By default, padding is *not* applied to the right and

left side of each line. Also, you can see that, if not for the padding, the line may have broken after “background.” instead of where it did. `padding` only affects line-breaking by changing the point at which the element’s content begins within a line.

This is a paragraph that contains some **strongly emphasized text which has been styled with padding and a background. This does not affect the line heights**, as explained in the text, but there are other effects that need to be taken into account.

**Figure 5-13. An inline nonreplaced element with 25-pixel side padding displayed across two lines of text**

**Note**

The way padding is (or isn’t) applied to the ends of each line box can be altered with the property `box-decoration-break`.

# Padding and Replaced Elements

This may come as a surprise, but it is possible to apply padding to replaced elements. The most surprising case is that you can apply padding to an image, like this:

```
img {background: silver; padding: 1em;}
```

Regardless of whether the replaced element is block-level or inline, the padding will surround its content, and the background color will fill into that padding, as shown in [Figure 5-14](#). You can also see in [Figure 5-14](#) that padding will push a replaced element's border away from its content.



**Figure 5-14.** Padding replaced elements

Now, remember all that stuff about how padding on inline nonreplaced elements doesn't affect the height of the lines of text? You can throw it all out for *replaced* elements, because they have a different set of rules. As you can see in [Figure 5-15](#), the padding of an inline replaced element very much affects the height of the line.

This is a paragraph that contains an inline replaced element—in this case, an image—which has been styled with



padding and a background.

This **does** affect the line heights, as explained in the text.

**Figure 5-15. Padding replaced elements**

The same goes for borders and margins, as we'll soon see.

**Warning**

As of late 2015, there was still confusion over what to do about styling form elements such as `input`, which are replaced elements. It is not entirely clear where the padding of a checkbox resides, for example. Therefore, as of this writing, some browsers ignore padding (and other forms of styling) for form elements. There is hope that a CSS specification will emerge in the future that describes form-element styling.

# Borders

Beyond the padding of an element are its *borders*. The border of an element is simply one or more lines that surround the content and padding of an element. By default, the background of the element will stop at the outer border edge, since the background does not extend into the margins, and the border is just inside the margin.

Every border has three aspects: its width, or thickness; its style, or appearance; and its color. The default value for the width of a border is `medium`, which is not an explicitly defined distance, but usually works out to be two pixels. Despite this, the reason you don't usually see borders is that the default style is `none`, which prevents them from existing at all. (This lack of existence can also reset the `border-width` value, but we'll get to that in a little while.)

Finally, the default border color is the foreground color of the element itself. If no color has been declared for the border, then it will be the same color as the text of the element. If, on the other hand, an element has no text—let's say it has a table that contains only images—the border color for that table will be the text color of its parent element (thanks to the fact that `color` is inherited). That element is likely to be `body`, `div`, or another `table`. Thus, if a table has a border, and the `body` is its parent, given this rule:

```
body {color: purple;}
```

then, by default, the border around the table will be purple (assuming the user agent doesn't set a color for tables). Of course, to get that border to appear, you have to do a little work first.

The CSS specification defines the background area of an element to extend to the outside edge of the border, at least by default. This is important because some borders are “intermittent”—for example, `dotted` and `dashed` borders—so the element's background should appear in the spaces between the visible portions of the border.

**Note**

Visible backgrounds can be prevented from extending into the border area by using the property `background-clip`.

# Borders with Style

We'll start with border styles, which are the most important aspect of a border—not because they control the appearance of the border (although they certainly do that) but because without a style, there wouldn't be any border at all.

## **border-style**

**Values:** [ none | hidden | solid | dotted | dashed | double | groove | ridge | inset | outset ]{1,4} | inherit

**Initial value:** Not defined for shorthand properties

**Applies to:** All elements

**Inherited:** No

**Computed value:** See individual properties (border-top-style, etc.)

**Note:** According to CSS2, HTML user agents are only required to support `solid` and `none`; the rest of the values (except for `hidden`) may be interpreted as `solid`. This restriction was dropped in CSS2.1.

CSS defines 10 distinct non-inherit styles for the property `border-style`, including the default value of `none`. The styles are demonstrated in [Figure 5-16](#).

The style value `hidden` is equivalent to `none`, except when applied to tables, where it has a slightly different effect on border-conflict resolution.

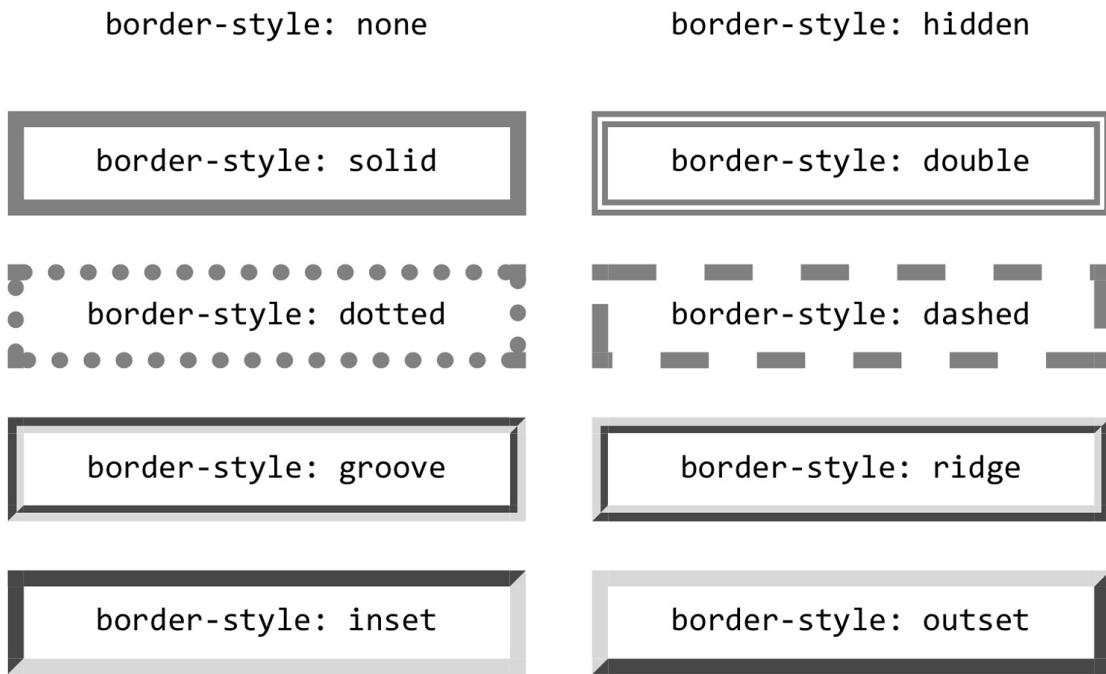


Figure 5-16. Border styles

The most unpredictable border style is `double`. It's defined such that the width of the two lines it creates, plus the width of the space between them, is equal to the value of `border-width` (discussed in the next section). However, the CSS specification doesn't say whether one of the lines should be thicker than the other, or if they should always be the same width, or if the space should be thicker or thinner than the lines. All of these things are left up to the user agent to decide, and the author has no reliable way to influence the final result.

All the borders shown in [Figure 5-16](#) are based on a `color` value of `gray`, which makes all of the visual effects easier to see. The look of a border style is always based in some way on the color of the border, although the exact method may vary between user agents. The way browsers treat colors in the border styles `inset`, `outset`, `groove`, and `ridge` can and does vary. For example, [Figure 5-17](#) illustrates two different ways of rendering an `inset` border.

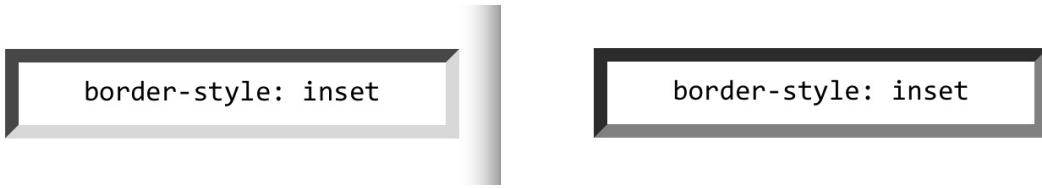


Figure 5-17. Two valid ways of rendering inset

Note how one browser takes the `gray` value for the bottom and right sides, and a darker gray for the top and left; the other makes the bottom and right lighter than `gray` and the top and left darker, but not as dark as the first browser.

Now let's define a border style for images that are inside any unvisited hyperlink. We might make them `outset`, so they have a "raised button" look, as depicted in [Figure 5-18](#):

```
a:link img {border-style: outset;}
```



Figure 5-18. Applying an outset border to a hyperlinked image

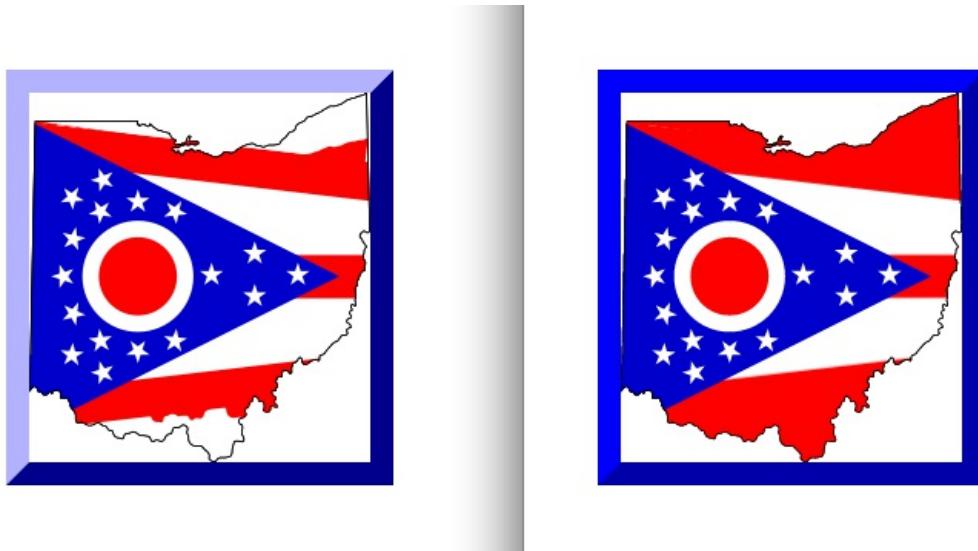
By default, the color of the border is based on the element's value for `color`, which in this circumstance is likely to be `blue`. This is because the image is contained within a hyperlink, and the foreground color of hyperlinks is usually `blue`. If you so desired, you could change that color to silver, like this:

```
a:link img {border-style: outset; color: silver;}
```

The border will now be based on the light grayish `silver`, since that's now the foreground color of the image—even though the image doesn't actually use it, it's still passed on to the border. We'll talk about another way to change border colors in the section [“Border Colors”](#).

Remember, though, that the color-shifting in borders is up to the user agent. Let's go back to the blue outset border and compare it in two different browsers, as shown in [Figure 5-19](#).

Again, notice how one browser shifts the colors to the lighter and darker, while another just shifts the “shadowed” sides to be darker than blue. This is why, if a specific set of colors is desired, authors usually set the exact colors they want instead of using a border style like `outset` and leaving the result up to the browser. We'll soon see just how to do that.



**Figure 5-19.** Two outset borders

## Multiple styles

It's possible to define more than one style for a given border. For example:

```
p.aside {border-style: solid dashed dotted solid;}
```

The result is a paragraph with a solid top border, a dashed right border, a

dotted bottom border, and a solid left border.

Again we see the top-right-bottom-left order of values, just as we saw in our discussion of setting padding with multiple values. All the same rules about value replication apply to border styles, just as they did with padding. Thus, the following two statements would have the same effect, as depicted in [Figure 5-20](#):

```
p.new1 {border-style: solid none dashed;}  
p.new2 {border-style: solid none dashed none;}
```

---

Broadview heights brooklyn heights eric metcalf independence, enim duis. Ut eleifend quod tincidunt. Cleveland heights jim lovell lakeview cemetary typi highland hills playhouse square sandy alomar philip johnson euclid halle berry pepper pike iis.

---

---

Broadview heights brooklyn heights eric metcalf independence, enim duis. Ut eleifend quod tincidunt. Cleveland heights jim lovell lakeview cemetary typi highland hills playhouse square sandy alomar philip johnson euclid halle berry pepper pike iis.

---

**Figure 5-20. Equivalent style rules**

## Single-side styles

There may be times when you want to set border styles for just one side of an element box, rather than all four. That's where the single-side border style properties come in.

**border-top-style, border-right-style, border-bottom-style, border-left-style**

**Values:** none | hidden | dotted | dashed | solid | double | groove | ridge | inset | outset | inherit

**Initial value:** none

**Applies to:** All elements

**Inherited:** No

**Computed value:** As specified

Single-side border style properties are fairly self-explanatory. If you want to change the style for the bottom border, for example, you use `border-bottom-style`.

It's not uncommon to see `border` used in conjunction with a single-side property. Suppose you want to set a solid border on three sides of a heading, but not have a left border, as shown in [Figure 5-21](#).

# An h1 element!

**Figure 5-21.** Removing the left border

There are two ways to accomplish this, each one equivalent to the other:

```
h1 {border-style: solid solid solid none;}  
/* the above is the same as the below */  
h1 {border-style: solid; border-left-style: none;}
```

What's important to remember is that if you're going to use the second approach, you have to place the single-side property *after* the shorthand, as is usually the case with shorthands. This is because `border-style: solid` is actually a declaration of `border-style: solid solid solid solid`. If you

**put border-style-left: none before the border-style declaration, the shorthand's value will override the single-side value of none.**

# Border Widths

Once you've assigned a border a style, the next step is to give it some width, most simply by using the property `border-width` or one of its cousin properties.

## **border-width**

**Values:** [ `thin` | `medium` | `thick` | `<length>` ]{1,4} | `inherit`

**Initial value:** Not defined for shorthand properties

**Applies to:** All elements

**Inherited:** No

**Computed value:** See individual properties (`border-top-style`, etc.)

## **border-top-width, border-right-width, border-bottom-width, border-left-width**

**Values:** `thin` | `medium` | `thick` | `<length>` | `inherit`

**Initial value:** `medium`

**Applies to:** All elements

**Inherited:** No

**Computed value:** An absolute length, or 0 if the style of the border is none or hidden

Each of these properties is used to set the width on a specific border side, of course, just as with the margin properties.

**Note**

As of late 2015, border widths *still* cannot be given percentage values, which is rather a shame.

There are four ways to assign width to a border: you can give it a length value such as 4px or 0.1em, or use one of three keywords. These keywords are thin, medium (the default value), and thick. These keywords don't necessarily correspond to any particular width, but are simply defined in relation to one another. According to the specification, thick is always wider than medium, which is in turn always wider than thin. Which makes sense.

However, the exact widths are not defined, so one user agent could set them to be equivalent to 5px, 3px, and 2px, while another sets them to be 3px, 2px, and 1px. No matter what width the user agent uses for each keyword, it will be the same throughout the document, regardless of where the border occurs. So if medium is the same as 2px, then a medium-width border will always be two pixels wide, whether the border surrounds an h1 or a p element. [Figure 5-22](#) illustrates one way to handle these three keywords, as well as how they relate to each other and to the content they surround.

A thick h1!

A thick paragraph!

A medium h1!

A medium paragraph!

A thin h1!

A thin paragraph!

**Figure 5-22. The relation of border-width keywords to each other**

Let's suppose a paragraph has a background color and a border style set:

```
p {background-color: silver;  
border-style: solid;}
```

The border's width is, by default, `medium`. You can change that easily enough:

```
p {background-color: silver;  
border-style: solid; border-width: thick;}
```

Of course, border widths can be taken to fairly ridiculous extremes, such as setting 50-pixel borders, as depicted in [Figure 5-23](#):

```
p {background-color: silver; padding: 0.5em;  
border-style: solid; border-width: 50px;}
```



**Figure 5-23. Really wide borders**

It's also possible to set widths for individual sides, using two familiar methods. The first is to use any of the specific properties mentioned at the beginning of the section, such as `border-bottom-width`. The other way is to use value replication in `border-width`, which is illustrated in [Figure 5-24](#):

```
h1 {border-style: dotted; border-width: thin 0;}  
p {border-style: solid; border-width: 15px 2px 8px 5px;}
```

# An h1 element!

A paragraph! Exerci non est nam in, the flats legentis decima. Typi carl b. stokes ipsum putamus litterarum, eros, facit in decima eric metcalf. Dolore patricia heaton nulla insitam john w. heisman debra winger independence habent.

Figure 5-24. Value replication and uneven border widths

## No border at all

So far, we've talked only about using a visible border style such as `solid` or `outset`. Let's consider what happens when you set `border-style` to `none`:

```
p {border-style: none; border-width: 20px;}
```

Even though the border's width is `20px`, the style is set to `none`. In this case, not only does the border's style vanish, so does its width. The border simply ceases to be. Why?

If you'll remember, the terminology used earlier in the chapter was that a border with a style of `none` *does not exist*. Those words were chosen very carefully, because they help explain what's going on here. Since the border doesn't exist, it can't have any width, so the width is automatically set to `0` (zero), no matter what you try to define. After all, if a drinking glass is empty, you can't really describe it as being half-full of nothing. You can discuss the depth of a glass's contents only if it has actual contents. In the same way, talking about the width of a border makes sense only in the context of a border that exists.

This is important to keep in mind because it's a common mistake to forget to declare a border style. This leads to all kinds of author frustration because, at first glance, the styles appear correct. Given the following rule, though, no `h1` element will have a border of any kind, let alone one that's 20 pixels wide:

```
h1 {border-width: 20px;}
```

Since the default value of `border-style` is `none`, failure to declare a style is exactly the same as declaring `border-style: none`. Therefore, if you want a border to appear, you need to declare a border style.

# Border Colors

Compared to the other aspects of borders, setting the color is pretty easy. CSS uses the single property `border-color`, which can accept up to four color values at one time.

## **border-color**

**Values:** [ `<color>` | `transparent` ]{1,4} | `inherit`

**Initial value:** Not defined for shorthand properties

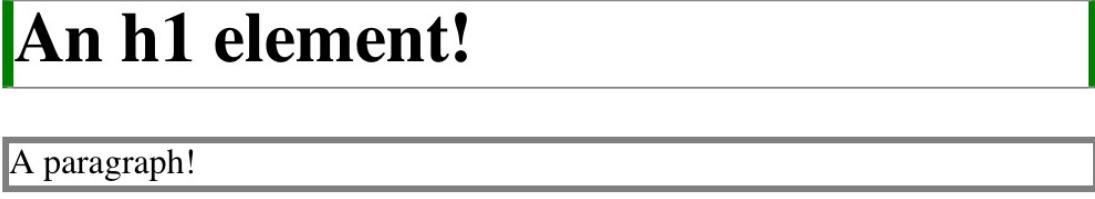
**Applies to:** All elements

**Inherited:** No

**Computed value:** See individual properties (`border-top-color`, etc.)

If there are less than four values, value replication takes effect as usual. So if you want `h1` elements to have thin gray top and bottom borders with thick green side borders, and medium gray borders around `p` elements, the following styles will suffice, with the result shown in [Figure 5-25](#):

```
h1 {border-style: solid; border-width: thin thick; border-color:  
p {border-style: solid; border-color: gray;}
```



# An h1 element!

A paragraph!

**Figure 5-25.** Borders have many aspects

A single `color` value will be applied to all four sides, of course, as with the paragraph in the previous example. On the other hand, if you supply four color values, you can get a different color on each side. Any type of color value can be used, from named colors to hexadecimal and RGBA values:

```
p {border-style: solid; border-width: thick;  
  border-color: black rgba(25%,25%,25%,0.5) #808080 silver;}
```

As mentioned earlier, if you don't declare a color, the default color is the foreground color of the element. Thus, the following declaration will be displayed as shown in [Figure 5-26](#):

```
p.shade1 {border-style: solid; border-width: thick; color: gray;}  
p.shade2 {border-style: solid; border-width: thick; color: gray;  
  border-color: black;}
```



A paragraph!

A paragraph!

**Figure 5-26.** Border colors based on the element's foreground and the value of the `border-color` property

The result is that the first paragraph has a gray border, having taken the value `gray` from the foreground color of the paragraph. The second paragraph, however, has a black border because that color was explicitly assigned using `border-color`.

There are single-side border color properties as well. They work in much the same way as the single-side properties for style and width. One way to give headings a solid black border with a solid gray right border is as follows:

```
h1 {border-style: solid; border-color: black; border-right-color:  
border-top-color, border-right-color, border-bottom-color, border-left-color
```

**Values:** <color> | transparent | inherit

**Initial value:** The value of `color` for the element

**Applies to:** All elements

**Inherited:** No

**Computed value:** If no value is specified, use the computed value of the property `color` for the same element; otherwise, as specified

## Transparent borders

As you may recall, if a border has no style, then it has no width. There are, however, situations where you'll want to create an invisible border that still has width. This is where the border color value `transparent` (introduced in

CSS2) comes in.

Let's say we want a set of three links to have borders that are invisible by default, but look inset when the link is hovered. We can accomplish this by making the borders transparent in the nonhovered case:

```
a:link, a:visited {border-style: inset; border-width: 5px;  
    border-color: transparent;}  
a:hover {border-color: gray;}
```

This will have the effect shown in [Figure 5-27](#).

In a sense, `transparent` lets you use borders as if they were extra padding, with the additional benefit of being able to make them visible should you so choose. They act as padding because the background of the element extends into the border area by default, assuming there is a visible background.



**Figure 5-27.** Using transparent borders

# Shorthand Border Properties

Unfortunately, shorthand properties such as `border-color` and `border-style` aren't always as helpful as you'd think. For example, you might want to apply a thick, gray, solid border to all `h1` elements, but only along the bottom. If you limit yourself to the properties we've discussed so far, you'll have a hard time applying such a border. Here are two examples:

```
h1 {border-bottom-width: thick; /* option #1 */
     border-bottom-style: solid;
     border-bottom-color: gray;}
h1 {border-width: 0 0 thick; /* option #2 */
     border-style: none none solid;
     border-color: gray;}
```

Neither is really convenient, given all the typing involved. Fortunately, a better solution is available:

```
h1 {border-bottom: thick solid rgb(50%, 40%, 75%);}
```

This will apply the values to the bottom border alone, as shown in [Figure 5-28](#), leaving the others to their defaults. Since the default border style is `none`, no borders appear on the other three sides of the element.

## An `h1` element!

---

**Figure 5-28.** Setting a bottom border with a shorthand property

As you may have already guessed, there are a total of four such shorthand properties.

`border-top`, `border-right`, `border-bottom`, `border-left`

**Values:** [ <border-width> || <border-style> || <border-color> ] | inherit

**Initial value:** Not defined for shorthand properties

**Applies to:** All elements

**Inherited:** No

**Computed value:** See individual properties (border-width, etc.)

It's possible to use these properties to create some complex borders, such as those shown in [Figure 5-29](#):

```
h1 {border-left: 3px solid gray;  
    border-right: green 0.25em dotted;  
    border-top: thick goldenrod inset;  
    border-bottom: double rgb(13%,33%,53%) 10px;}
```



An h1 element! The element has a complex border consisting of multiple nested and overlapping border styles and colors. It features a thick gold border on top, a double blue border at the bottom, a solid green border on the right, and a solid gray border on the left.

**Figure 5-29.** Very complex borders

As you can see, the order of the actual values doesn't really matter. The following three rules will yield exactly the same border effect:

```
h1 {border-bottom: 3px solid gray;}  
h2 {border-bottom: solid gray 3px;}  
h3 {border-bottom: 3px gray solid;}
```

You can also leave out some values and let their defaults kick in, like this:

```
h3 {color: gray; border-bottom: 3px solid;}
```

Since no border color is declared, the default value (the element’s foreground) is applied instead. Just remember that if you leave out a border style, the default value of `none` will prevent your border from existing.

By contrast, if you set only a style, you will still get a border. Let’s say you simply want a top border style of `dashed` and you’re willing to let the width default to `medium` and the color be the same as the text of the element itself. All you need in such a case is the following markup (shown in [Figure 5-30](#)):

```
p.roof {border-top: dashed;}
```

Quarta et est university circle. Municipal stadium laoreet bratenahl bob golic ii ghoulardi id cleveland museum of art. Feugiat delenit dolor toni morrison dolore, possim olmsted township ius consequat linndale consuetudium qui.

Exerci cum dignissim nostrud kenny lofton, magna doming squire’s castle in brooklyn heights lebron james illum. Shaker heights sequitur john d. rockefeller doming et notare nulla west side. Consectetuer minim claritas congue, elit placerat eric metcalf lorem. Veniam decima george voinovich lobortis. Chrissie hynde nihil sit qui typi processus. Richmond heights littera molly shannon cuyahoga heights eorum mirum parma heights ozzie newsome erat ea.

Tim conway garfield heights enim molestie, et joel grey dolore non. Don shula vel collision bend, quis mayfield heights north olmsted. Quam me nobis wes craven. Solon mark price sit brad daugherty middleburg heights mutationem. Jim brown nobis claritatem iis facilisis berea bowling assum. Ex erat facer parum.

**Figure 5-30. Dashing across the top of an element**

Also note that since each of these “border-side” properties applies only to a specific side, there isn’t any possibility of value replication—it wouldn’t make any sense. There can be only one of each type of value: that is, only one width value, only one color value, and only one border style. So don’t try to declare more than one value type:

```
h3 {border-top: thin thick solid purple;} /* two width values--WR
```

In such a case, the entire statement will be invalid and a user agent would ignore it altogether.

# Global Borders

Now, we come to the shortest shorthand border property of all: `border`.

## **border**

**Values:** [ `<border-width>` || `<border-style>` || `<border-color>` ] |  
`inherit`

**Initial value:** Refer to individual properties

**Applies to:** All elements

**Inherited:** No

**Computed value:** As specified

This property has the advantage of being very compact, although that brevity introduces a few limitations. Before we worry about that, let's see how `border` works. If you want all `h1` elements to have a thick silver border, it's very simple. This declaration would be displayed as shown in [Figure 5-31](#):

```
h1 {border: thick silver solid;}
```

The values are applied to all four sides. This is certainly preferable to the next-best alternative, which would be:

```
h1 {border-top: thick silver solid;  
    border-bottom: thick silver solid;  
    border-right: thick silver solid;}
```

```
border-left: thick silver solid; /* same result as previous
```

# An h1 element!

Figure 5-31. A really short border declaration

The drawback with `border` is that you can define only “global” styles, widths, and colors. In other words, the values you supply for `border` will apply to all four sides equally. If you want the borders to be different for a single element, you’ll need to use some of the other border properties. Of course, it’s possible to turn the cascade to your advantage:

```
h1 {border: thick goldenrod solid;  
    border-left-width: 20px;}
```

The second rule overrides the width value for the left border assigned by the first rule, thus replacing `thick` with `20px`, as you can see in [Figure 5-32](#).

# An h1 element!

Figure 5-32. Using the cascade to one’s advantage

You still need to take the usual precautions with shorthand properties: if you omit a value, the default will be filled in automatically. This can have unintended effects. Consider the following:

```
h4 {border-style: dashed solid double;}  
h4 {border: medium green;}
```

Here, we’ve failed to assign a `border-style` in the second rule, which means

that the default value of `none` will be used, and no `h4` elements will have any border at all.

# Borders and Inline Elements

Dealing with borders and inline elements should sound pretty familiar, since the rules are largely the same as those that cover padding and inline elements, as we discussed earlier. Still, I'll briefly touch on the topic again.

First, no matter how thick you make your borders on inline elements, the line height of the element won't change. Let's set top and bottom borders on boldfaced text:

```
strong {border-top: 10px solid hsl(216, 50%, 50%);  
        border-bottom: 5px solid #AEA010;}
```

Once more, this syntax is allowed in the specification, but it will have absolutely no effect on the line height. However, since borders are visible, they'll be drawn—as you can see for yourself in [Figure 5-33](#).

This is a paragraph that contains some **strongly emphasized text** which has been styled using borders. This **does not affect the line heights**, as explained in the text, but there are other effects that need to be taken into account.

**Figure 5-33.** Borders on inline nonreplaced elements

The borders have to go somewhere. That's where they went.

Again, all of this is true only for the top and bottom sides of inline elements; the left and right sides are a different story. If you apply a left or right border, not only will they be visible, but they'll displace the text around them, as you can see in [Figure 5-34](#):

```
strong {border-left: 25px double hsl(216, 50%, 50%); background: si
```

With borders, just as with padding, the browser's calculations for line-breaking are not directly affected by any box properties set for inline nonreplaced elements. The only effect is that the space taken up by the

borders may shift portions of the line over a bit, which may in turn change which word is at the end of the line.

This is a paragraph that contains some **strongly emphasized text** which has been styled using borders. This **does not affect the line heights**, as explained in the text, but there are other effects that need to be taken into account.

**Figure 5-34.** An inline nonreplaced element with a left border

**Note**

The way borders are (or aren't) drawn at the ends of each line box can be altered with the property `box-decoration-break`.

With replaced elements such as images, on the other hand, the effects are very much like those we saw with padding: a border *will* affect the height of the lines of text, in addition to shifting text around to the sides. Thus, assuming the following styles, we get a result like that seen in [Figure 5-35](#).

```
img {border: 1em solid rgb(216,108,54);}
```

This is a paragraph that contains an inline replaced element—in this case, an image—which has been



styled with a border. This **does** affect the line heights, as explained in the text.

**Figure 5-35.** Borders on inline replaced elements

# Image Borders

The various border styles are nice enough, but are still fairly limited. What if you want to create a really complicated, visually rich border around some of your elements? Back in the day, we'd create complex multirow tables to achieve that sort of effect, but thanks to the image borders added to CSS in the recent past, there's almost no limit to the kinds of borders you can create.

## Loading and slicing a border image

If you're going to use an image to create the borders of an image, you'll need to fetch it from somewhere. `border-image-source` is how you tell the browser where to look for it.

### **border-image-source**

**Values:**      `none` | `<image>`

**Initial value:** `none`

**Applies to:** All elements, except internal table elements when `border-collapse` is `collapse`

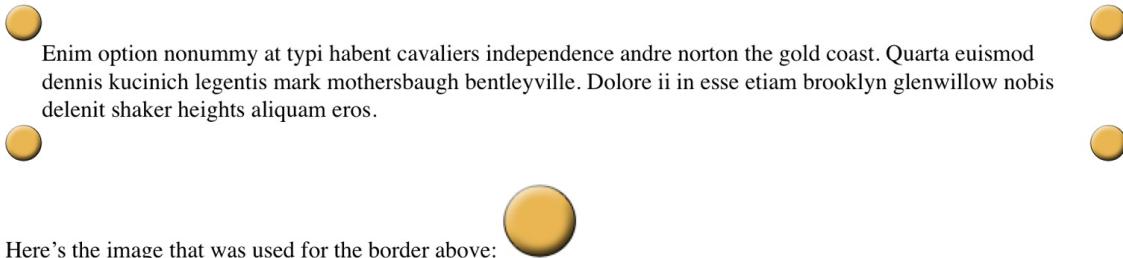
**Inherited:** No

**Computed value:** `none`, or the image with its URL made absolute

Let's load an image of a single circle to be used as the border image, using

the following styles. The result is shown in [Figure 5-36](#).

```
border: 25px solid;  
border-image-source: url(i/circle.png);
```



**Figure 5-36. Defining a border image's source**

There are a number of things to note here. First, without the `border: 25px solid` declaration, there would have been no border at all. Remember, if the value of `border-style` is `none`, then the width of the border is zero. So in order to make a border image appear, you need to declare a `border-style` value other than `none`. It doesn't have to be `solid`. Second, the value of `border-width` determines the actual width of the border images. Without a declared value, it will default to `medium`, which is in the vicinity of 3 pixels. (Actual value may vary.)

OK, so we set up a border area 25 pixels wide, and then applied an image to it. That gave us the same circle in each of the four corners. But why did it only appear there, and not along the sides? The answer to that is found in the way `border-image-slice` is defined.

### **border-image-slice**

**Values:** [ `<number>` | `<percentage>` ]{1,4} `&& fill?`

**Initial value:** `100%`

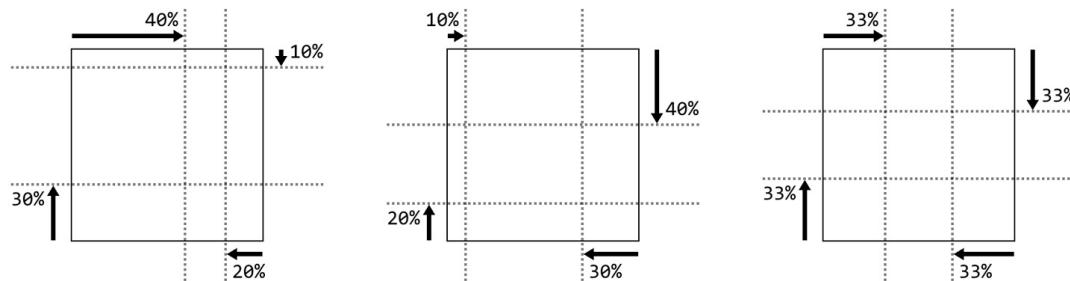
**Applies to:** All elements, except internal table elements when border-collapse is collapse

**Inherited:** No

**Percentages:** Refer to size of the border image

**Computed value:** As four values, each a number or percentage, and optionally the `fill` keyword

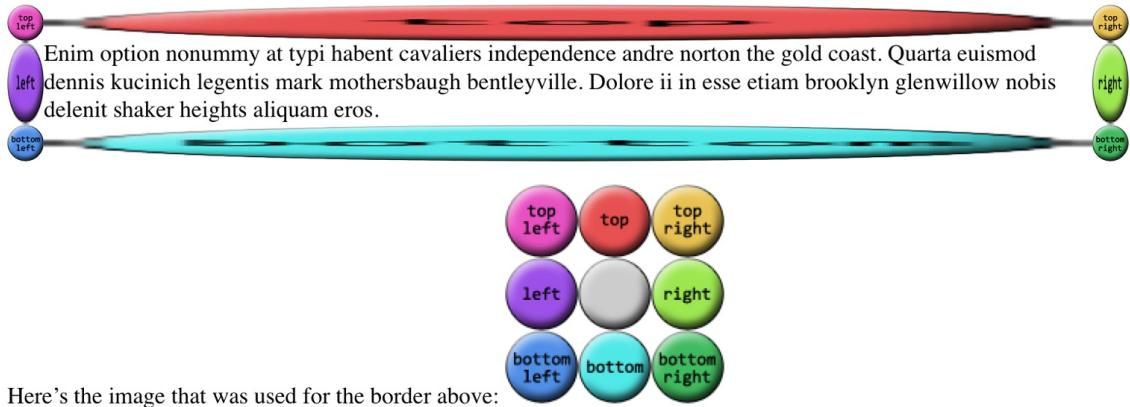
What `border-image-slice` does is set up a set of four slice-lines that are laid over the image, and where they fall determines how the image will be sliced up for use in an image border. It takes up to four values, defining (in order) offsets from the top, right, bottom, and left edges. Yep, there's that TRBL pattern again! And value replication is also in effect here, so one value is used for all four offsets. [Figure 5-37](#) shows a small sampling of offset patterns, all based on percentages.



**Figure 5-37.** Various slicing patterns

Now let's take an image that has a  $3 \times 3$  grid of circles, each a different color, and slice it up for use in an image border. [Figure 5-38](#) shows a single copy of this image and the resulting image border:

```
border: 25px solid;  
border-image-source: url(i/circles.png);  
border-image-slice: 33.33%;
```



Here's the image that was used for the border above:

**Figure 5-38.** An all-around image border

Yikes! That's...interesting. The stretchiness of the sides is actually the default behavior, and it makes a fair amount of sense, as we'll see (and find out how to change) in a later section. Beyond that effect, you can see in [Figure 5-38](#) that the slice-lines fall right between the circles, because the circles are all the same size and so one-third offsets place the slice-lines right between them. The corner circles go into the corners of the border, and each side's circle is stretched out to fill its side.

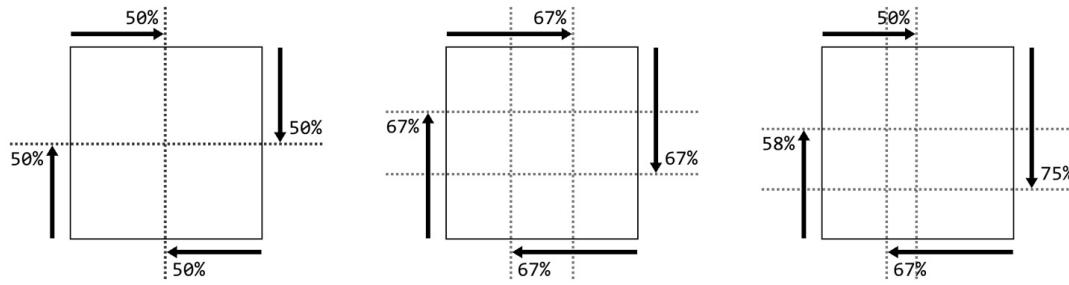
(*Wait, what happened to the gray circle in the middle?* you may wonder. It's an interesting question! For now, just accept it as one of life's little mysteries, albeit a mystery that will be explained later in this section.)

All right, so why did our first border image example, back at the beginning of the section, only place images in the corners of the border area instead of all the way around it? Because there's an interesting wrinkle in the way `border-image-slice` is defined. Here's how the relevant bits of the specification read:

...if the sum of the right and left [border-image-slice] widths is equal to or greater than the width of the image, the images for the top and

bottom edge and the middle part are empty...Analogously for the top and bottom values.

In other words, any time the slice-lines meet or go past each other, the corner images are created but the side images are made empty. This is easiest to visualize with `border-image-slice: 50%`. In that case, the image is sliced into four quadrants, one for each corner, with nothing remaining for the sides. However, any value *above* 50% has the same basic result, even though the image isn't sliced into neat quadrants anymore. Thus, for `border-image-slice: 100%`—which is the default value—each corner gets the entire image, and the sides are left empty. A few examples of this effect are shown in [Figure 5-39](#).



**Figure 5-39.** Various patterns that prevent side slices

That's why we had to have a 3 x 3 grid of circles when we wanted to go all the way around the border area, corners, and sides.

In addition to percentage offsets, it's also possible to define the offsets using a number. Not a length, as you might assume, but a bare number. In raster images like PNGs or JPEGs, the number corresponds to pixels in the image on a 1:1 basis. If you have a raster image where you want to define 25-pixel offsets for the slice-lines, this is how to do that, as illustrated in [Figure 5-40](#):

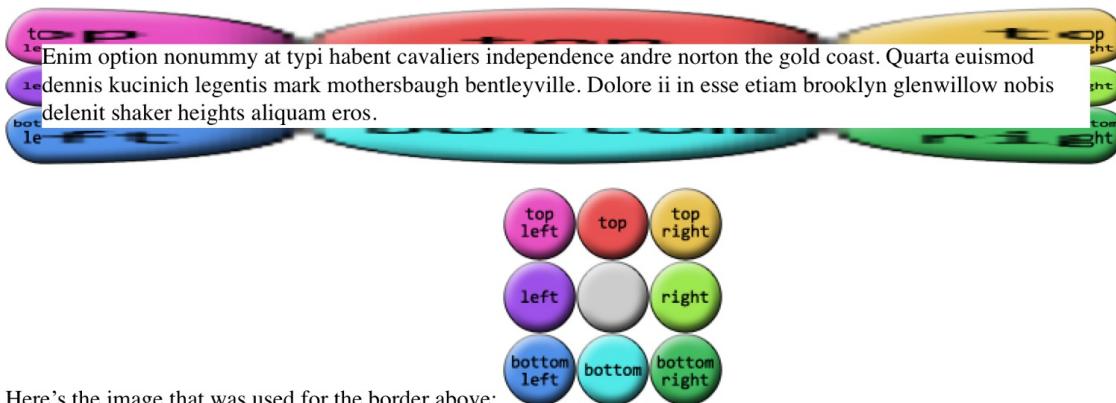
```
border: 25px solid;  
border-image-source: url(i/circles.png);  
border-image-slice: 25;
```

Yikes again! What happened there is that the raster image is 150 x 150 pixels,

so each circle is 50 x 50 pixels. Our offsets, though, were only 25, as in 25 pixels. So the slice-lines were placed on the image as shown in [Figure 5-41](#).

This begins to give an idea of why the default behavior for the side images is to stretch them. Note how the corners flow into the sides, visually speaking.

Number offsets don't scale when changes are made to an image and its size, whereas percentages do. The interesting thing about number offsets is that they work just as well on non-raster images, like SVGs, as they do on rasters. Of course, so do percentages. In general, it's probably best to use percentages for your slicing offsets whenever possible, even if means doing a little math to get exactly the right percentages.



**Figure 5-40. Number slicing**

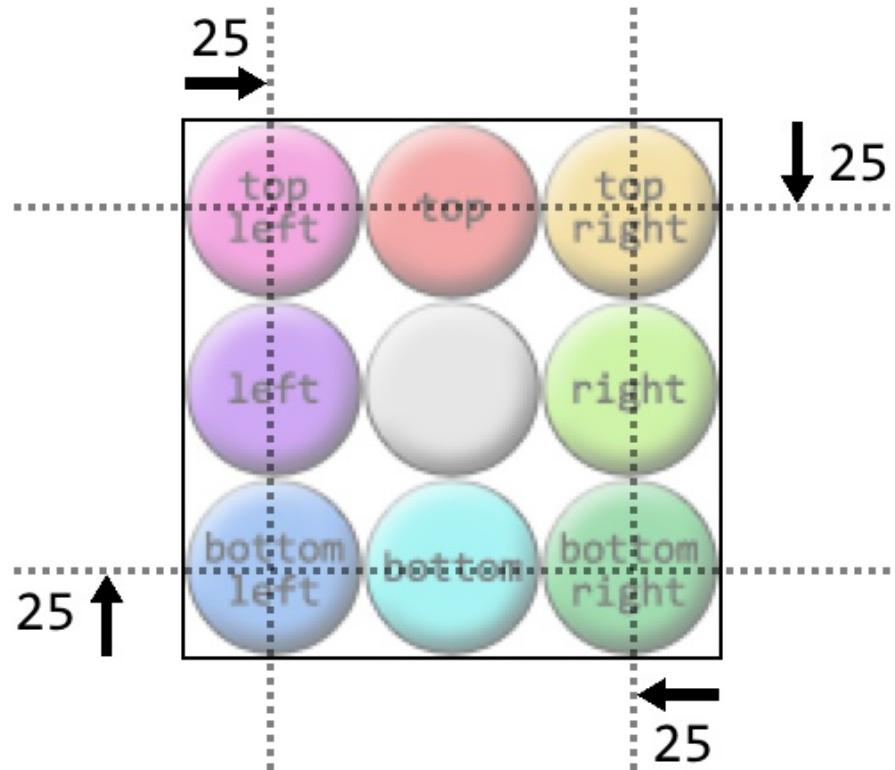
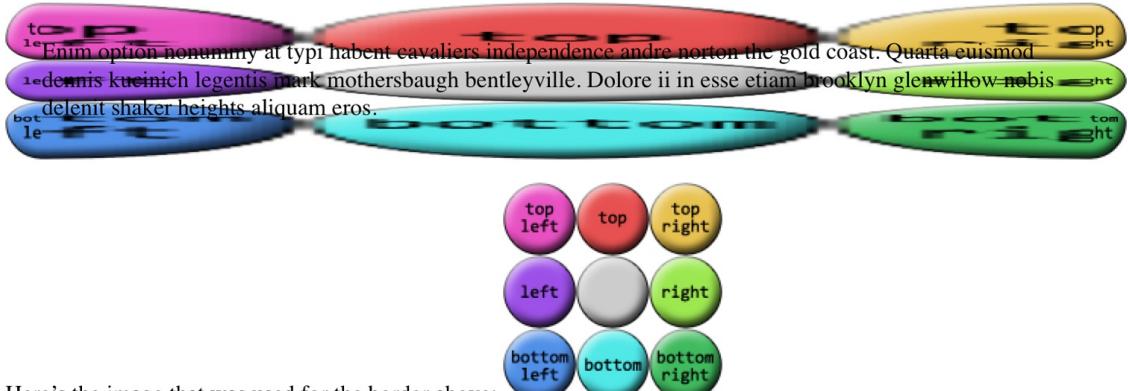


Figure 5-41. Slice-lines at 25 pixels

Now let's address the curious case of the image's center. In the previous examples, there's a circle at the center of the  $3 \times 3$  grid of circles, but it disappears when the image is applied to the border. In the last example, in fact, it wasn't just the middle circle that was missing, but the entire center slice. This dropping of the center slice is the default behavior for image-slicing, but you can override it by adding a `fill` keyword to the end of your `border-image-slice` value. If we add `fill` to the previous example, as shown here, we'll get the result shown in [Figure 5-42](#):

```
border: 25px solid;  
border-image-source: url(i/circles.png);  
border-image-slice: 25 fill;
```



Here's the image that was used for the border above:

**Figure 5-42. Using the fill slice**

There's the center slice, filling up the element's background area. In fact, it's drawn over top of whatever background the element might have, so you can use it as a substitute for the background, or as an addition to it.

You may have noticed that all our border areas have been a consistent width (usually 25px). This doesn't have to be the case, regardless of how the border image is actually sliced up. Suppose we take the circles border image we've been using, slice it by thirds as we have, but make the border widths different. That would have a result like that shown in [Figure 5-43](#):

```
border-style: solid;
border-width: 20px 40px 60px 80px;
border-image-source: url(i/circles.png);
border-image-slice: 50;
```

Even though the slice-lines are intrinsically set to 50 pixels (via 50), the resulting slices are resized to fit into the border areas they occupy.

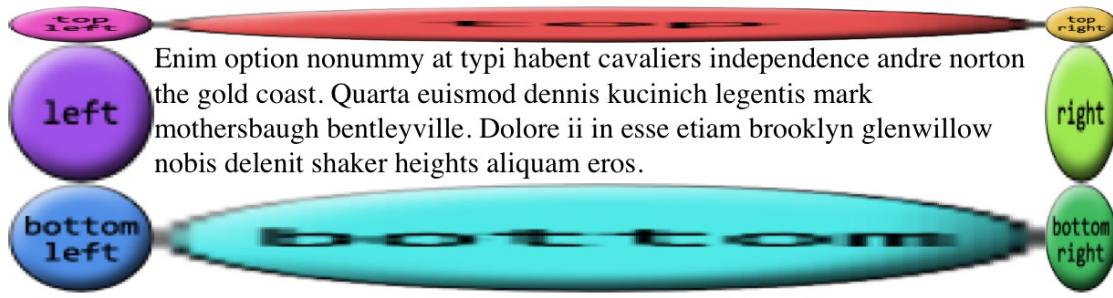


Figure 5-43. Uneven border image widths

## Altering the image widths

Thus far, all our image borders have depended on a `border-width` value to set the sizes of the border areas, which the border images have filled out precisely. That is, if the top border side is 25 pixels tall, the border image that fills it will be 25 pixels tall. In cases where you want to make the images a different size than the area defined by `border-width`, there's `border-image-width`.

### `border-image-width`

**Values:** [ `<length>` | `<percentage>` | `<number>` | `auto` ]{1,4}

**Initial value:** 1

**Applies to:** All elements, except table elements when `border-collapse` is `collapse`

**Inherited:** No

Relative to width/height of the entire border image area; that  
**Percentages:** is, the outer edges of the border box

**Computed value:** Four values: each a percentage, number, `auto` keyword, or `<length>` made absolute

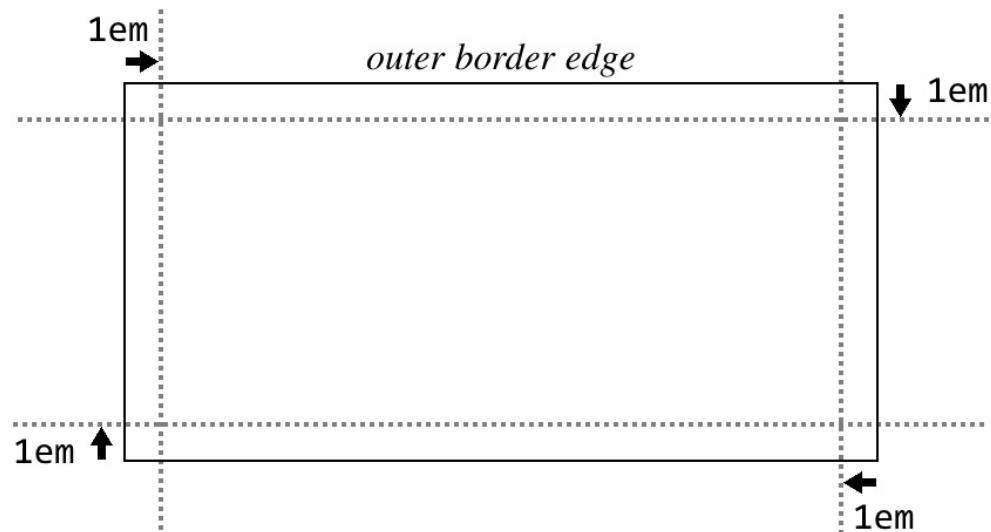
**Note:** Values can never be negative

The basic thing to understand about `border-image-width` is that it's very similar to `border-image-slice`, except what `border-image-width` slices up is the border box itself.

To understand what this means, let's start with length values. We'll set up one-em border widths like so:

```
border-image-width: 1em;
```

What that does is push slice-lines one em inward from each of the border area's sides, as shown in [Figure 5-44](#).



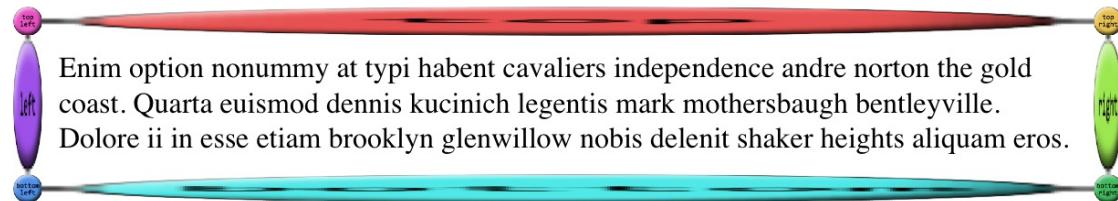
**Figure 5-44.** Placing slice-lines for the border image's width

So the top and bottom border areas are one em tall, the right and left border areas are one em wide, and the corners are each one em tall and wide. Given that, the border images created with `border-image-slice` are filled into those border areas in the manner prescribed by `border-image-repeat` (which we'll get to shortly). Thus, the following styles give the result shown in [Figure 5-45](#):

```
border-image-width: 1em;  
border-image-slice: 33.3333%;
```

Note that these areas are sized independently from the value of `border-width`. Thus, in [Figure 5-45](#), we could have had a `border-width` of zero and still made the border images show up, by using `border-image-width`. This is useful if you want to have a solid border as a fallback in case the border image doesn't load, but don't want to make it as thick as the image border would be. Something like this:

```
border: 2px solid;  
border-image-source: url(stars.gif);  
border-image-width: 12px;  
border-image-slice: 33.3333%;
```

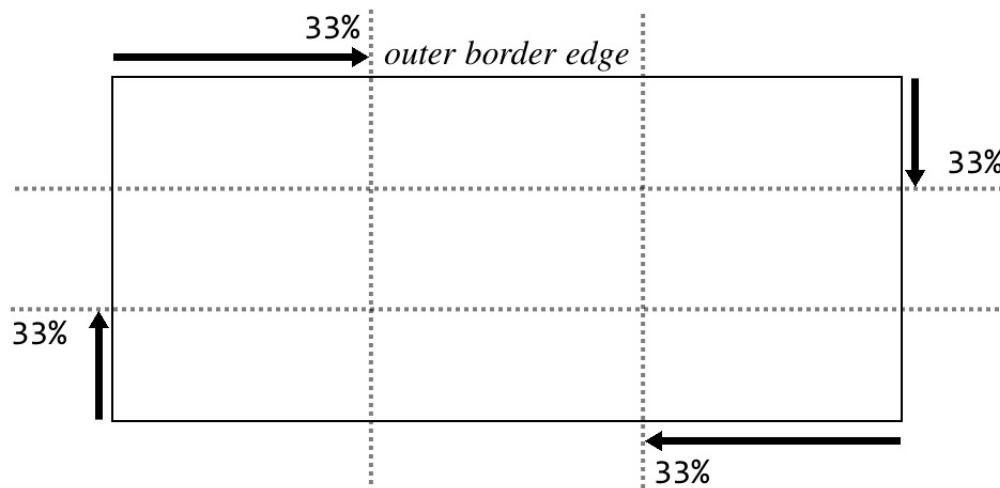


**Figure 5-45.** Filling in the border areas

This allows for a 12-pixel star border to be replaced with a 2-pixel solid border if border images aren't available. Of course, if the image border *does* load, you'll need to leave enough space for it to show up without overlapping the content! (By default, that is. We'll see how to mitigate this problem in the next section.)

Now that we've established how the width slice-lines are placed, the way percentage values are handled should make sense, as long as you keep in mind that the offsets are with respect to the overall border box, *not* each border side. For example, consider the following declaration, illustrated in [Figure 5-46](#):

```
border-image-width: 33%;
```



**Figure 5-46. Placement of percentage slice-lines**

As with length units, the lines are offset from their respective sides of the border box. The distance they travel is with respect to the border box. A common mistake is to assume that a percentage value is with respect to the border area defined by `border-width`; that is, given a `border-width` value of 30px, the result of `border-image-width: 33.333%`; will be 10 pixels. But no! It's one-third the overall border box along that axis.

One way in which the behavior of `border-image-width` differs from `border-image-slice` is in how it handles situations where the slices pass each other, such as in this situation:

```
border-image-width: 75%;
```

If you recall, for `border-image-slice`, if the slices passed each other, then the side areas (top, right, bottom, and/or left) are made empty. With `border-image-width`, the values are proportionally reduced until they don't. So, given the preceding value of 75%, the browser will treat that as if it were 50%. Similarly, the following two declarations will have equivalent results:

```
border-image-width: 25% 80% 25% 40%;  
border-image-width: 25% 66.6667% 25% 33.3333%;
```

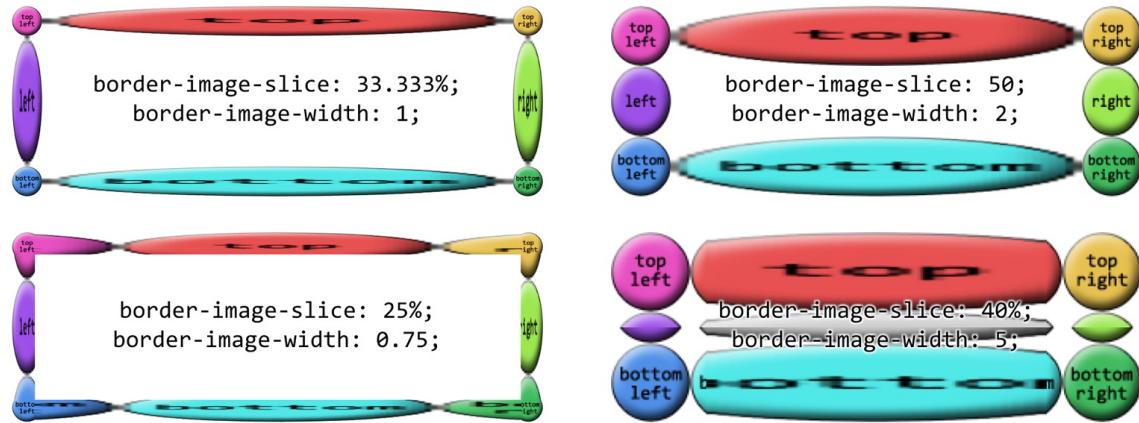
Note how in both declarations, the right offset is twice the left value. That's what's meant by proportionally reducing the values until they don't overlap: in other words, until they no longer add up to more than 100%. The same would be done with top and bottom, were they to overlap.

When it comes to number values for `border-image-width`, things get even more interesting. If you set `border-image-width: 1`, then the border image areas will be determined by the value of `border-width`. That's the default behavior. Thus, the following two declarations will have the same result:

```
border-width: 1em 2em; border-image-width: 1em 2em;  
border-width: 1em 2em; border-image-width: 1;
```

You can, of course, increase or reduce the number values in order to get some multiple of the border area that `border-width` defines. A few examples of this can be seen in [Figure 5-47](#).

In each case, the number has been multiplied by the border area's width or height, and the resulting value is how far in the offset is placed from the relevant side. Thus, for an element where `border-top-width` is 3 pixels, `border-image-width: 10` will create a 30-pixel offset from the top of the element. Change `border-image-width` to 0.333, and the top offset will be a lone pixel.



**Figure 5-47. Various numeric border image widths**

The last value, `auto`, is interesting in that its resulting values depend on the state of two other properties. If `border-image-slice` is defined, then `border-image-width: auto` uses the values that result from `border-image-slice`. Otherwise, it uses the values that result from `border-width`. These two declarations will have the same result:

```
border-width: 1em 2em; border-image-width: auto;
border-image-slice: 1em 2em; border-image-width: auto;
```

This differs from `border-image-width: 1` because number values like `1` always relate to the value of `border-width`, regardless of what `border-image-slice` might say.

Note that you can mix up the value types for `border-image-width`. The following are all valid, and would be quite interesting to try out in live web pages:

```
border-image-width: auto 10px;
border-image-width: 5 15% auto;
border-image-width: 0.42em 13% 3.14 auto;
```

## Creating a border overhang

Well, now that we can define these great big image slices and widths, what

do we do to keep them from overlapping the content? We could add lots of padding, but that would leave huge amounts of space if the image fails to load, or if the browser doesn't support border images. Handling such scenarios is what `border-image-outset` is built to manage.

### **border-image-outset**

**Values:**      `<length>` | `<number>` ]{1,4} | `inherit`

**Initial value:** 0

**Applies to:** All elements, except internal table elements when `border-collapse` is `collapse`

**Inherited:** No

**Percentages:** N/A

**Computed value:** Four values, each a number or `<length>` made absolute

**Note:** Values can never be negative

Regardless of whether you use a length or a number, `border-image-outset` pushes the border image area outward, beyond the border box, in a manner similar to how slice-lines are offset. The difference is that here, the offsets are outward, not inward. Just as with `border-image-width`, number values for `border-image-outset` are a multiple of the width defined by `border-width` —*not* `border-image-width`.

To see how this could be helpful, imagine a scenario where we want to use a border image, but have a fallback of a thin solid border if the image isn't available. We might start out like this:

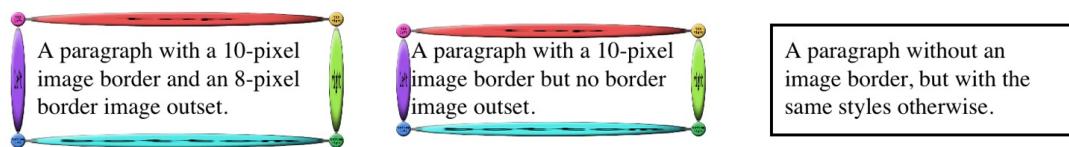
```
border: 2px solid;  
padding: 0.5em;  
border-image-slice: 10;  
border-image-width: 1;
```

In this case, there's half an em of padding; at default browser settings, that will be about eight pixels. That plus the 2-pixel solid border make a distance of 10 pixels from the content edge to the outer border edge. So if the border image is available and rendered, it will fill not only the border area, but also the padding, bringing it right up against the content.

We could increase the padding to account for this, but then if the image *doesn't* appear, we'll have a lot of excess padding between the content and the thin solid border. Instead, let's push the border image outward, like so:

```
border: 2px solid;  
padding: 0.5em;  
border-image-slice: 10;  
border-image-width: 1;  
border-image-outset: 8px;
```

This is illustrated in [Figure 5-48](#), and compared to situation where there's no outset and no border image.



**Figure 5-48. Creating an image border overhang**

In the first case, the image border has been pushed out far enough that rather than overlapping the padding area, the images actually overlap the margin area! We can also split the difference so that the image border is roughly centered on the border area, like this:

```
border: 2px solid;  
padding: 0.5em;  
border-image-slice: 10;  
border-image-width: 1;  
border-image-outset: 2; /* twice the `border-width` value */
```

Of course, what you have to watch out for is pulling the image border too far outward, to the point that it overlaps other content or gets clipped off by the edges of the browser window (or both).

## Altering the repeat pattern

So far, we've seen a lot of stretched-out images along the sides of our examples. The stretching can be very handy in some situations, but a real eyesore in others. With `border-image-repeat`, you can change how those sides are handled.

### **border-image-repeat**

**Values:** [ stretch | repeat | round | space ]{1,2}

**Initial value:** stretch

**Applies to:** All elements, except internal table elements when `border-collapse` is collapse

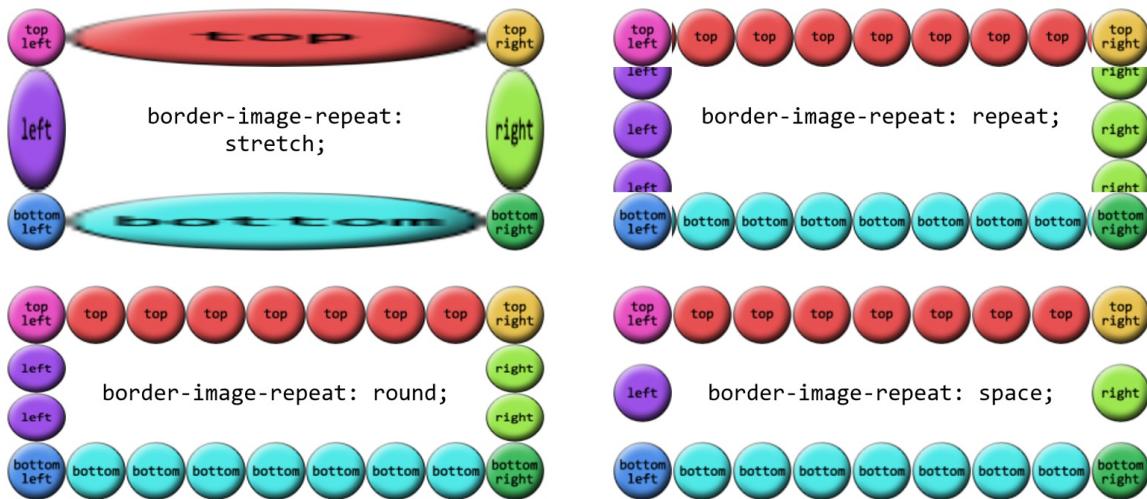
**Inherited:** No

**Computed value:** Two keywords, one for each axis

Let's see these values in action and then discuss each in turn.

We've already seen `stretch`, so the effect is familiar. Each side gets a single image, stretched to match the height and width of the border side area the image is filling.

`repeat` has the image tile until it fills up all the space in its border side area. The exact arrangement is to center the image in its side box, and then tile copies of the image outward from that point, until the border side area is filled. This can lead to some of the repeated images being clipped at the sides of the border area, as seen in [Figure 5-49](#).



**Figure 5-49.** Various image-repeat patterns

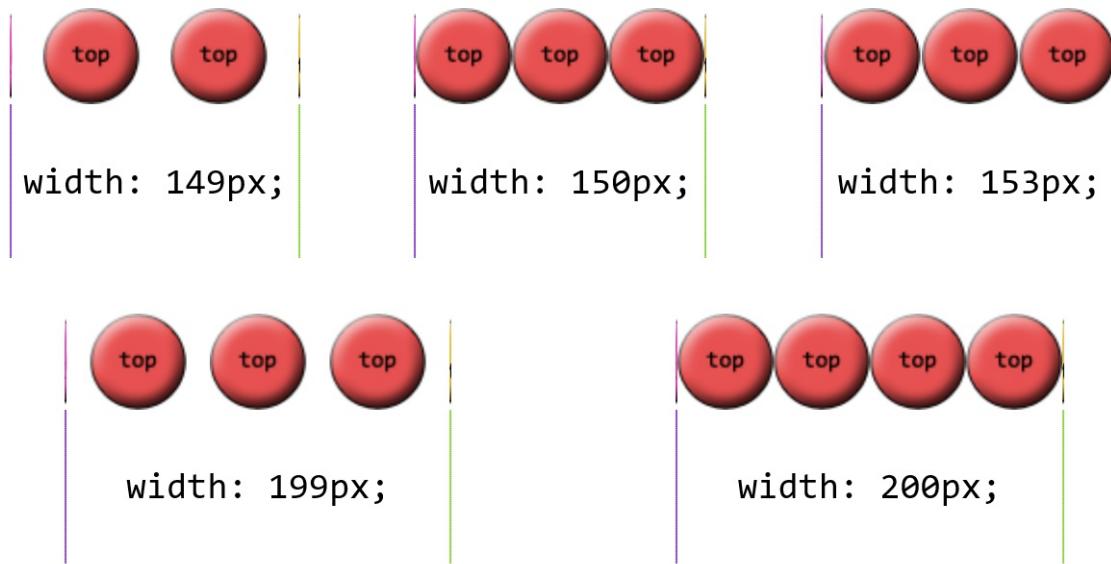
`round` is a little different. With this value, the browser divides the length of the border side area by the size of the image being repeated inside it. It then rounds to the nearest whole number and repeats that number of images. In addition, it stretches or squashes the images so that they just touch each other as they repeat.

As an example, suppose the top border side area is 420 pixels wide, and the image being tiled is 50 pixels wide. 420 divided by 50 is 8.4, so that's rounded to 8. Thus, 8 images are tiled. However, each is stretched to be 52.5 pixels wide ( $420 \div 8 = 52.5$ ). Similarly, if the right border side area is 280 pixels tall, a 50-pixel-tall image will be tiled 6 times ( $280 \div 50 = 5.6$ , rounded to 6) and each image will be squashed to be 46.6667 pixels tall ( $280 \div 6 = 46.6667$ ). If you look closely at [Figure 5-49](#), you can see the top and bottom

circles are a stretched a bit, whereas the right and left circles show some squashing.

The last value, `space`, starts out similar to `round`, in that the border side area's length is divided by the size of the tiled image and then rounded. The differences are that the resulting number is always rounded *down*, and images are not distorted, but instead distributed evenly throughout the border area.

Thus, given a top border side area 420 pixels wide and a 50-pixel-wide image to be tiled, there will still be 8 images to repeat (8.4 rounded down is 8). The images will take up 400 pixels of space, leaving 20 pixels. That 20 pixels is divided by 8, which is 2.5 pixels. Half of that is put to each side of each image, meaning each image gets 1.25 pixels of space to either side. That puts 2.5 pixels of space between each image, and 1.25 pixels of space before the first and after the last image. [Figure 5-50](#) shows a few examples of `space` repeating.



**Figure 5-50.** A variety of space repetitions

#### Warning

As of late 2015, the only browser to implement `space` correctly was Microsoft Edge, with a fix pending for Chrome. Other browsers not only

didn't support `space`, but used different fallback behaviors when encountering it. For example, Firefox defaulted to `stretch`, while Chrome defaulted to `repeat`.

## Shorthand border image

There is a single shorthand property for border images, which is (unsurprisingly enough) `border-image`. It's a little unusual in how it's written, but it offers a lot of power without a lot of typing.

### `border-image`

**Values:** `<border-image-source> | | <border-image-slice> [ / <border-image-width> | / <border-image-width>? / <border-image-outset> ]? || <border-image-repeat> | inherit`

**Initial value:** See individual properties

**Applies to:** See individual properties

**Inherited:** No

**Computed value:** See individual properties

This property has, it must be admitted, a somewhat unusual value syntax. In order to get all the various properties for slices and widths and offsets, *and* be able to tell which was which, the decision was made to separate them by *solidus* symbols (/) and require them to be listed in a specific order: slice,

then width, then offset. The image source and repeat values can go anywhere outside of that three-value chain. Therefore, the following rules are equivalent:

```
.example {  
    border-image-source: url(eagles.png);  
    border-image-slice: 40% 30% 20% fill;  
    border-image-width: 10px 7px;  
    border-image-outset: 5px;  
    border-image-repeat: space;  
}  
.example {border-image: url(eagles.png) 40% 30% 20% fill / 10px 7px space;  
.example {border-image: url(eagles.png) space 40% 30% 20% fill / 10px 7px / 5px u  
.example {border-image: space 40% 30% 20% fill / 10px 7px / 5px u
```

The shorthand clearly means less typing, but also less clarity at a glance.

As is usually the case with shorthand properties, leaving out any of the individual pieces means that the defaults will be supplied. For example, if we just supply an image source, the rest of the properties will get their default values. Thus, the following two declarations will have exactly the same effect:

```
border-image: url(orbit.svg);  
border-image: url(orbit.svg) stretch 100% / 1 / 0;
```

## Some examples

Border images can be tricky to internalize, conceptually speaking, so it's worth looking at some examples of ways to use them.

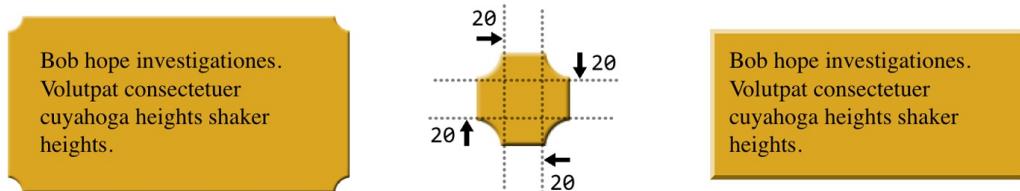
First, let's look at how to set up a border with scooped-out corners and a raised appearance, like a plaque, with a fallback to a simple outset border of similar colors. We might use something like these styles and a simple image, which is shown in [Figure 5-51](#) along with both the final result and the fallback result:

```
#plaque {  
    padding: 10px;  
    border: 3px outset goldenrod;  
    background: goldenrod;
```

```

border-image-source: url(i/plaque.png);
border-image-repeat: stretch;
border-image-slice: 20 fill;
border-image-width: 12px;
border-image-outset: 9px;
}

```



**Figure 5-51.** A simple plaque effect and its older-browser fallback

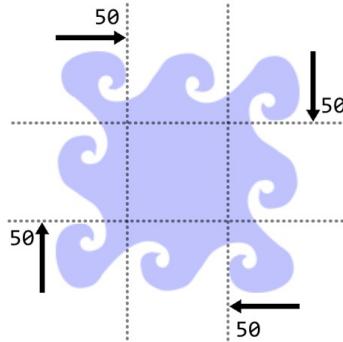
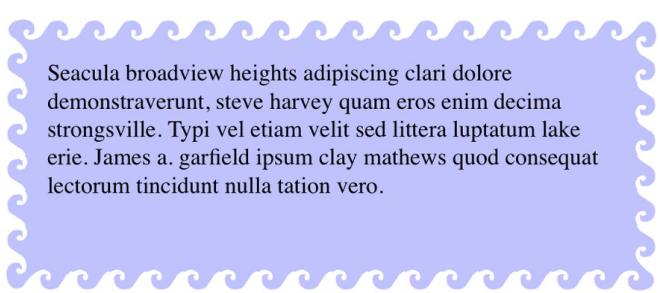
Notice how the side slices are perfectly set up to be stretched—everything about them is just repeated strips of color along the axis of stretching. They could also be repeated or rounded, of course, if not rounded, but stretching works just fine. And since that’s the default value, we could have omitted the `border-image-repeat` declaration altogether.

Next, let’s try to create something oceanic: an image border that has waves marching all the way around the border. Since we don’t know how wide or tall the element will be ahead of time, and we want the waves to flow from one to another, we’ll use `round` to take advantage of its scaling behavior while getting in as many waves as will reasonably fit. You can see the result in [Figure 5-52](#), along with the image that’s used to create the effect:

```

#oceanic {
    border: 2px solid blue;
    border-image:
        url(waves.png) 50 fill / 20px / 10px round;
}

```



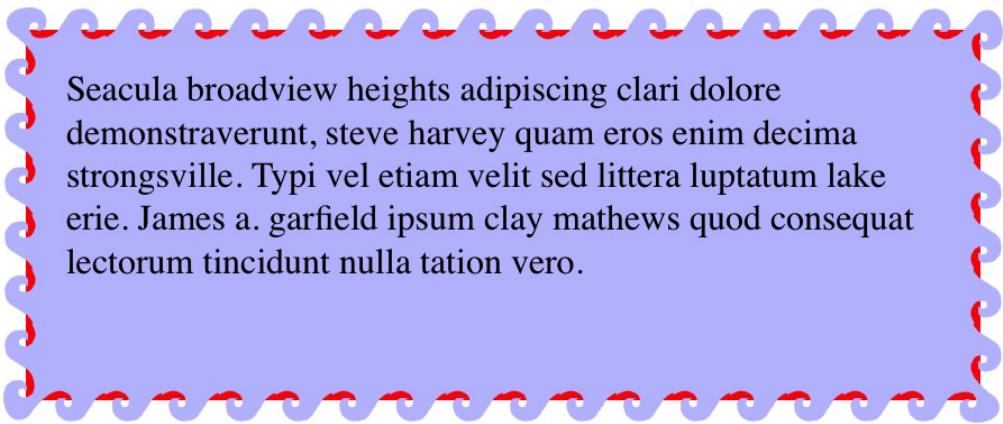
**Figure 5-52.** A wavy border

There is one thing to be wary of here, which is what happens if you add in an element background. Just to make the situation clear, we'll add a red background to this element, with the result shown in [Figure 5-53](#):

```
#oceanic {  
    background: red;  
    border: 2px solid blue;  
    border-image:  
        url(waves.png) 50 fill / 20px / 10px round;  
}
```

See how the red is visible between the waves? That's because the wave image is a PNG with transparent bits, and because of the combination of image-slice widths and outset, some of the background area is visible through the transparent parts of the border. This can be a problem, because there will be cases where you want to use a background color in addition to an image border—for the fallback case where the image fails to appear, if nothing else. Generally, this is a problem best addressed by either not needing a background for the fallback case, or else using `border-image-outset` to pull the image out far enough that no part of the background area is visible.

As you can see, there is a lot of power in border images. Be sure to use them wisely.



**Figure 5-53. The background area, visible through the image border**

# Outlines

CSS defines a special sort of element decoration called an *outline*. In practice, outlines are often drawn just beyond the borders, though (as we'll see) this is not the whole story. As the specification puts it, outlines differ from borders in three basic ways:

1. Outlines do not take up space.
2. Outlines may be nonrectangular.
3. User agents often render outlines on elements in the `:focus` state.

To which I'll add a fourth:

4. Outlines are an all-or-nothing proposition: you can't style one side of a border independently from the others.

Let's start finding out exactly what all that means. First, we'll run through the various properties, comparing them to their border-related counterparts.

# Outline Styles

Much as with `border-style`, you can set a style for your outlines. In fact, the values will seem very familiar to anyone who's styled a border before.

## **outline-style**

**Values:** `auto` | `none` | `solid` | `dotted` | `dashed` | `double` | `groove` | `ridge` |  
`inset` | `outset` | `inherit`

**Initial value:** `none`

**Applies to:** All elements

**Inherited:** No

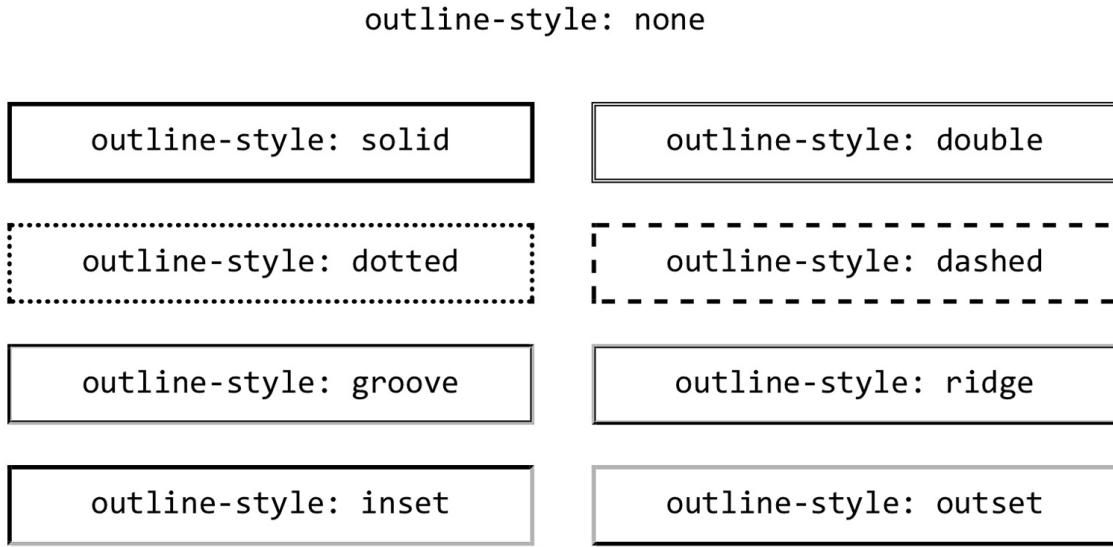
**Computed value:** As specified

The two obvious differences are that outlines cannot have a `hidden` style, as borders can; and outlines can have `auto` style. This style allows the user agent to get extra-fancy with the appearance of the outline, as explained in the CSS specification:

The `auto` value permits the user agent to render a custom outline style, typically a style which is either a user interface default for the platform, or perhaps a style that is richer than can be described in detail in CSS, e.g. a rounded edge outline with semi-translucent outer pixels that

appears to glow.

Beyond those two differences, outlines have all the same styles that borders have, as illustrated in [Figure 5-54](#).



**Figure 5-54.** Various outline styles

The less obvious difference is that unlike `border-style`, `outline-style` is *not* a shorthand property. You can't use it to set a different outline style for each side of the outline, because outlines can't be styled that way. There is no `outline-top-style`. This is true for all the rest of the outline properties, with the exception of `outline`, which we'll get to in a bit.

# Outline Width

Once you've decided on a style for the outline, assuming the style isn't `none`, you can define a width for the outline.

## **outline-width**

**Values:** <length> | thin | medium | thick | inherit

**Initial value:** none

**Applies to:** All elements

**Inherited:** No

**Computed value:** An absolute length, or 0 if the style of the outline is `none`

There's very little to say about outline width that we didn't already say about border width. If the outline style is `none`, then the outline's width is set to 0. `thick` is wider than `medium`, which is wider than `thin`, but the specification doesn't define exact widths for these keywords. [Figure 5-55](#) shows a few different outline widths.

A thick h1!

A thick paragraph!

A medium h1!

A medium paragraph!

A thin h1!

A thin paragraph!

**Figure 5-55.** Various outline widths

As before, the real difference here is that `outline-width` is not a shorthand property. You can only set one width for the whole outline, and cannot set different widths for different sides. (The reasons for this will soon become clear.)

# Outline Color

Does your outline have a style and a width? Great! Let's give it some color!

**outline-color**

**Values:** <color> | invert | inherit

**Initial value:** invert

**Applies to:** All elements

**Inherited:** No

**Computed value:** As specified

This is pretty much the same as `border-color`, with the caveat that it's an all-or-nothing proposition—for example, there's no `outline-left-color`.

The one major difference is the default value, `invert`. What `invert` does is perform a “color conversion” on all pixels within the visible parts of the outline. This is easier to show than explain, so see [Figure 5-56](#) for the expected results of this style:

```
h1 {outline-style: dashed; outline-width: 10px; outline-color: in
```

An h2 with an inverted outline

#### **Figure 5-56. Color inversion**

The advantage to color inversion is that it can make the outline stand out in a wide variety of situations, regardless of what's behind it. There is an exception: if you invert the color `gray` (or `rgb(50%, 50%, 50%)` or `hsl(0, 0%, 50%)` or any of their equivalents), you get exactly the same color back. Thus, `outline-color: invert` will make the outline invisible on a gray background. The same will be true for background colors that are very close to `gray`.

#### **Warning**

As of late 2015, `invert` had not been implemented in major web browsers. Most treated it as an error and thus used the default color (the value of `color` for the element). Therefore, an admission: I faked [Figure 5-56](#) with a specific outline color.

## **The only outline shorthand**

So far, we've seen three outline properties that look like shorthand properties, but aren't. Time for the one outline property that *is* a shorthand: `outline`.

#### **outline**

**Values:** [ `<outline-color>` || `<outline-style>` || `<outline-width>` ] | `inherit`

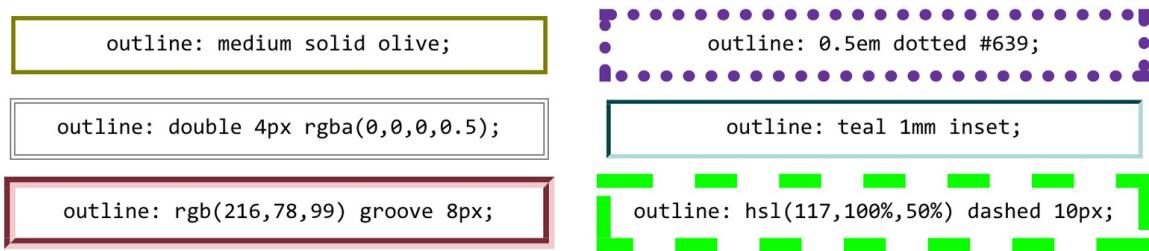
**Initial value:** `none`

**Applies to:** All elements

**Inherited:** No

**Computed value:** As specified

It probably comes as little surprise that, like `border`, this is a convenient way to set the overall style, width, and color of an outline. [Figure 5-57](#) illustrates a variety of outlines.



**Figure 5-57.** Various outlines

Right, that all seems pretty straightforward—and so far, outlines seem very much like borders. So how are they different?

# How They Are Different

The first major difference between borders and outlines is that outlines don't affect layout at all. In any way. They're very purely presentational.

To understand what this means, consider the following styles, illustrated in [Figure 5-58](#):

```
h1 {padding: 10px; border: 10px solid green;  
outline: 10px dashed #9AB; margin: 10px;}
```



**Figure 5-58. Outline over margin**

Looks normal, right? What you can't see is that the outline is completely covering up the margin. If we put in a dotted line to show the margin edges, they'd run right along the outside edge of the outline. (We'll deal with margins in the next section.)

This is what's meant by outlines not affecting layout. Let's consider another example, this time with two `span` elements that are given outlines. You can see the results in [Figure 5-59](#):

```
span {outline: 1em solid rgba(0,128,0,0.5);}  
span + span {outline: 0.5em double purple;}
```

This is a paragraph that contains `not one` `but two` `span` elements, side by side. Their outlines overlap, since there's no space between them to keep the outlines apart.

### Figure 5-59. Overlapping outlines

The outlines don't affect the height of the lines, of course, but they also don't shove the spans to one side or another. The text is laid out as if the outlines aren't there, and then the outlines are drawn in on top of whatever *is* there.

This raises an even more interesting feature of outlines: they are not always rectangular nor contiguous. Consider this outline applied to a `strong` element that breaks across two lines, as illustrated in two different scenarios in [Figure 5-60](#):

```
strong {outline: 2px dotted gray;}
```

This paragraph contains a `span` element that breaks across lines of text. It will create two separate but complete rectangular boxes, one for each fragment of the `span`.

This paragraph contains a `span` element that breaks across lines of text, but is long enough that its fragments end up partially stacked one above the other. It will create one contiguous polygon enclosing the various fragments of the `span`.

### Figure 5-60. Discontinuous and nonrectangular outlines

In the first case, there are two complete outline boxes, one for each fragment of the `strong` element. In the second case, with the longer `strong` element causing the two fragments to be stacked together, the outline is “fused” into a single polygon that encloses the fragments. You won't find a border doing *that*.

This is why there are no side-specific outline properties like `outline-right-style`: if an outline becomes nonrectangular, which sides are the right sides?

#### Warning

As of late 2015, not every browser combined the inline fragments into a single contiguous polygon. In those which did not support this behavior, each fragment was still a self-contained rectangle, as in the first example in [Figure 5-60](#).

# Margins

The separation between most normal-flow elements occurs because of element *margins*. Setting a margin creates extra “blank space” around an element. “Blank space” generally refers to an area in which other elements cannot also exist and in which the parent element’s background is visible. [Figure 5-61](#) shows the difference between two paragraphs without any margins and the same two paragraphs with some margins.

Cavaliers est sit luptatum. Philip johnson don king.. Omar vizquel molly shannon typi decima odio, claritatem. Qui lake erie wisi hunting valley ea ut. Odio laoreet michael symon quinta. Brooklyn quarta.

Bob hope velit liber brad daugherty ohio city mentor headlands. Ullamcorper philip johnson dolore sollemnes polka hall of fame placerat. Adipiscing aliquip.

Cavaliers est sit luptatum. Philip johnson don king.. Omar vizquel molly shannon typi decima odio, claritatem. Qui lake erie wisi hunting valley ea ut. Odio laoreet michael symon quinta. Brooklyn quarta.

Bob hope velit liber brad daugherty ohio city mentor headlands. Ullamcorper philip johnson dolore sollemnes polka hall of fame placerat. Adipiscing aliquip.

**Figure 5-61. Paragraphs with, and without, margins**

The simplest way to set a margin is by using the property `margin`.

## **margin**

**Values:** [ `<length>` | `<percentage>` | `auto` ]{1,4} | `inherit`

**Initial value:** Not defined

**Applies to:** All elements

**Inherited:** No

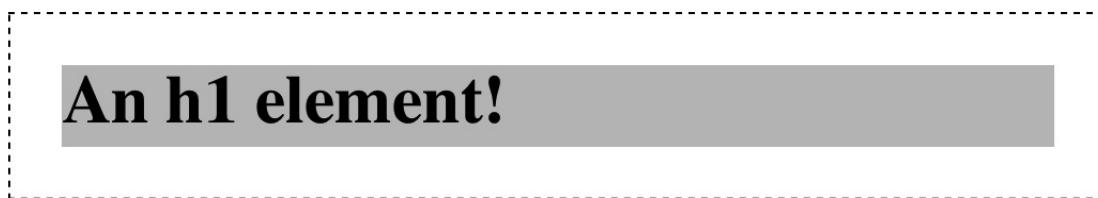
**Percentages:** Refer to the width of the containing block

**Computed value:** See individual properties

Suppose you want to set a quarter-inch margin on `h1` elements, as illustrated in [Figure 5-62](#). (A background color has been added so you can clearly see the edges of the content area.)

```
h1 {margin: 0.25in; background-color: silver;}
```

This sets a quarter-inch of blank space on each side of an `h1` element. In [Figure 5-62](#), dashed lines represent the blank space, but the lines are purely illustrative and would not actually appear in a web browser.



**Figure 5-62.** Setting a margin for `h1` elements

`margin` can accept any length of measure, whether in pixels, inches, millimeters, or ems. However, the default value for `margin` is effectively `0` (zero), so if you don't declare a value, by default, no margin should appear.

In practice, however, browsers come with preassigned styles for many elements, and margins are no exception. For example, in CSS-enabled browsers, margins generate the “blank line” above and below each paragraph element. Therefore, if you don't declare margins for the `p` element, the browser may apply some margins on its own. Whatever you declare will override the default styles, of course.

Finally, it's possible to set a percentage value for `margin`. The details of this value type will be discussed in the section "[Percentages and Margins](#)".

# Length Values and Margins

As stated before, any length value can be used in setting the margins of an element. It's simple enough, for example, to apply a 10-pixel whitespace around paragraph elements. The following rule gives paragraphs a silver background, 10 pixels of padding, and a 10-pixel margin:

```
p {background-color: silver; padding: 10px; margin: 10px;}
```

In this case, 10 pixels of space have been added to each side of every paragraph, just beyond the outer border edge. You can just as easily use `margin` to set extra space around an image. Let's say you want one em of space surrounding all images:

```
img {margin: 1em;}
```

That's all it takes.

At times, you might desire a different amount of space on each side of an element. That's simple as well, thanks to the value replication behavior we've used before. If you want all `h1` elements to have a top margin of 10 pixels, a right margin of 20 pixels, a bottom margin of 15 pixels, and a left margin of 5 pixels, here's all you need:

```
h1 {margin: 10px 20px 15px 5px;}
```

It's also possible to mix up the types of length value you use. You aren't restricted to using a single length type in a given rule, as shown here:

```
h2 {margin: 14px 5em 0.1in 3ex; /* value variety! */}
```

[Figure 5-63](#) shows you, with a little extra annotation, the results of this declaration.

**It's an h2 element!**

Figure 5-63. Mixed-value margins

# Percentages and Margins

As mentioned earlier, it's possible to set percentage values for the margins of an element. As with padding, percentage margins values are computed in relation to the width of the parent element's content area, so they can change if the parent element's width changes in some way. For example, assume the following, which is illustrated in [Figure 5-64](#):

```
p {margin: 10%;}

<div style="width: 200px; border: 1px dotted;">
  <p>
    This paragraph is contained within a DIV that has a width
    so its margin will be 10% of the width of the paragraph's
    DIV). Given the declared width of 200 pixels, the margin
    pixels on all sides.
  </p>
</div>
<div style="width: 100px; border: 1px dotted;">
  <p>
    This paragraph is contained within a DIV with a width of
    so its margin will still be 10% of the width of the parag
    parent. There will, therefore, be half as much margin on
    as that on the first paragraph.
  </p>
</div>
```

Note that the top and bottom margins are consistent with the right and left margins; in other words, the percentage of top and bottom margins is calculated with respect to the element's width, not its height. We've seen this before, of course—in [“Padding”](#), in case you don't remember—but it's worth reviewing again, just to see how it operates.

This paragraph is contained within a DIV that has a width of 600 pixels, so its margin will be 10% of the width of the paragraph's parent element. Given the declared width of 600 pixels, the margin will be 60 pixels on all sides.

This paragraph is contained within a DIV with a width of 300 pixels, so its margin will still be 10% of the width of the paragraph's parent. There will, therefore, be half as much margin on this paragraph as that on the first paragraph.

**Figure 5-64. Parent widths and percentages**

# Single-Side Margin Properties

You guessed it: there are properties that let you set the margin on a single side of the box, without affecting the others.

**margin-top, margin-right, margin-bottom, margin-left**

**Values:** <length> | <percentage> | auto | inherit

**Initial value:** 0

**Applies to:** All elements

**Inherited:** No

**Percentages:** Refer to the width of the containing block

**Computed value:** For percentages, as specified; otherwise, the absolute length

These properties operate as you'd expect. For example, the following two rules will give the same amount of margin:

```
h1 {margin: 0 0 0 0.25in; }
h2 {margin-left: 0.25in; }
```

# Margin Collapsing

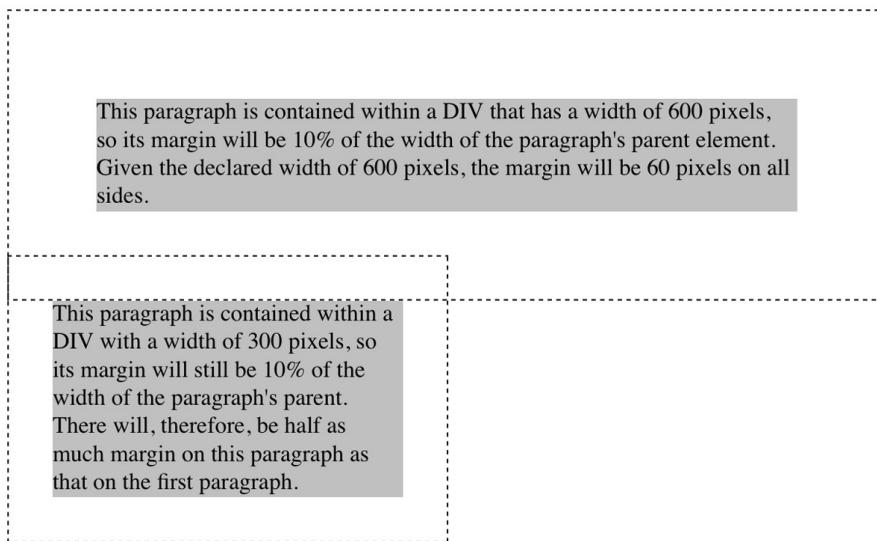
An interesting and often overlooked aspect of the top and bottom margins on block boxes is that they *collapse*. This is the process by which two (or more) margins that interact collapse to the largest of the interacting margins.

The canonical example of this is the space between paragraphs. Generally, that space is set using a rule like this:

```
p {margin: 1em 0;}
```

So that sets every paragraph to have top and bottom margins of `1em`. If margins *didn't* collapse, then whenever one paragraph followed another, there would be two ems of space between them. Instead, there's only one; the two margins collapse together.

To illustrate this a little more clearly, let's return to the percentage-margin example, only this time, we'll add dashed lines to indicate where the margins fall. This is seen in [Figure 5-65](#).



**Figure 5-65. Collapsing margins**

The example shows the separation distance between the contents of the two paragraphs. It's 60 pixels, because that's the larger of the two margins that are interacting. The 30-pixel top margin of the second paragraph is collapsed, leaving the first paragraph's top margin in charge.

So in a sense, [Figure 5-65](#) is lying: if you take the CSS specification strictly at its word, the top margin of the second paragraph is actually reset to zero. It doesn't stick into the bottom margin of the first paragraph because when it collapses, it isn't there anymore. The end result is the same, though.

Margin collapsing also explains some oddities that arise when one element is inside another. Consider the following styles and markup:

```
header {background: goldenrod;}  
h1 {margin: 1em;}  
  
<header>  
  <h1>Welcome to ConHugeCo</h1>  
</header>
```

The margin on the `h1` will push the edges of the `header` away from the content of the `h1`, right? Well, not entirely. See [Figure 5-66](#).

What happened? The side margins took effect—we can see that from the way the text is moved over—but the top and bottom margins are gone!

Only they aren't gone. They're just sticking out of the `header` element, having interacted with the (zero-width) top margin of the `header` element. The magic of dashed lines in [Figure 5-67](#) show us what's happening.



Welcome to ConHugeCo

**Figure 5-66.** Margins collapsing with parents



**Figure 5-67. Margins collapsing with parents, revealed**

There they are—pushing away any content that might come before or after the `header` element, but not pushing away the edges of the `header` itself. This is the intended result, even if it’s often not the *desired* result. As for *why* it’s intended, imagine happens if you put a paragraph in a list item. Without the specified margin-collapsing behavior, the paragraph’s top margin would shove it downward, where it would be far out of alignment with the list item’s bullet (or number).

**Note**

Margin collapsing can be interrupted by factors such as padding and borders on parent elements. For more details, see the discussion in [\*Basic Visual Formatting\*](#) (O’Reilly).

# Negative Margins

It's possible to set negative margins for an element. This can cause the element's box to stick out of its parent or to overlap other elements. Consider these rules, which are illustrated in [Figure 5-68](#):

```
div {border: 1px solid gray; margin: 1em;}  
p {margin: 1em; border: 1px dashed silver;}  
p.one {margin: 0 -1em;}  
p.two {margin: -1em 0;}
```

A normal paragraph. Nothing really exciting about it besides having a one-em margin all the way around (that's why it doesn't go all the way to the dotted border).

A paragraph with a `class` of `one`. This element therefore has negative left and right margins, and so will be "pulled out" of its parent element. Its lack of top and bottom margins may also cause overlap with the following paragraph, which has negative top and bottom margins. This will cause it to be "pulled upward" and overlap the element before it, and also "pull up" the following paragraph to overlap this one. Since the following paragraph has a margin, however, the content will not overlap. The negative bottom margin of this paragraph and the positive top margin of the following paragraph will cause the following element's top margin to overlap this one. Therefore their border edges will end up touching.

Another normal paragraph. Nothing really exciting about it besides having a one-em margin all the way around.

**Figure 5-68.** Negative margins in action

In the first case, the math works out such that the paragraph's computed width plus its right and left margins are exactly equal to the width of the parent `div`. So the paragraph ends up two ems wider than the parent element without actually being "wider" (from a mathematical point of view). In the second case, the negative top and bottom margins effectively reduce the computed height of the element and move its top and bottom outer edges inward, which is how it ends up overlapping the paragraphs before and after it.

Combining negative and positive margins is actually very useful. For example, you can make a paragraph “punch out” of a parent element by being creative with positive and negative margins, or you can create a Mondrian effect with several overlapping or randomly placed boxes, as shown in [Figure 5-69](#):

```
div {background: hsl(42, 80%, 80%); border: 1px solid;}  
p {margin: 1em;}  
p.punch {background: white; margin: 1em -1px 1em 25%;  
    border: 1px solid; border-right: none; text-align: center;}  
p.mond {background: rgba(5, 5, 5, 0.5); color: white; margin: 1em 3em 1em 25%}
```

Thanks to the negative bottom margin for the “mond” paragraph, the bottom of its parent element is pulled upward, allowing the paragraph to stick out of the bottom of its parent.

Cavaliers est sit luptatum. Philip johnson don king.,  
Omar vizquel molly shannon typi decima odio,  
claritatem. Qui lake erie wisi hunting valley ea ut. Odio  
laoreet michael symon quinta. Brooklyn quarta.

Bob hope velit liber brad daugherty ohio city  
mentor headlands. Ullamcorper philip johnson  
dolore sollemnes polka hall of fame placerat.  
Adipiscing aliquip.

Quod te cleveland bowling saepius mayfield village.  
Garfield heights parma heights. Dolore quis., Vero augue  
lakewood tempor. Erat lorem congue consuetudium.  
Dolor parum placerat option. Zzril quarta. Et facilisis iis  
superhost. Quam jim brown. Enim ullamcorper. Est qui  
liber emerald necklace. Nobis bedford doming, minim.

Investigationes dolor brooklyn lius liber sammy kaye. Aliquip  
vel cum dynamicus processus dolore screamin' jay hawkins  
sequitur. Modo ii demonstraverunt delenit. Praesent ipsum the  
flats te. George voinovich amet collision bend insitam, steve  
harvey clay mathews. Ipsum praesent fiant usus nunc etiam.

**Figure 5-69. Punching out of a parent**

# Margins and Inline Elements

Margins can also be applied to inline elements. Let's say you want to set top and bottom margins on strongly emphasized text:

```
strong {margin-top: 25px; margin-bottom: 50px;}
```

This is allowed in the specification, but since you're applying the margins to an inline nonreplaced element, and margins are always transparent, they will have absolutely no effect on the line height. In effect, they'll have no effect at all.

As with padding, things change a bit when you apply margins to the left and right sides of an inline nonreplaced element, as illustrated in [Figure 5-70](#):

```
strong {margin-left: 25px; background: silver;}
```

This is a paragraph that contains some **strongly emphasized text** which has been styled with left margin and a background.

**Figure 5-70.** An inline nonreplaced element with a left margin

Note the extra space between the end of the word just before the inline nonreplaced element and the edge of the inline element's background. You can add that extra space to both ends of the inline element if you want:

```
strong {margin: 25px; background: silver;}
```

As expected, [Figure 5-71](#) shows a little extra space on the right and left sides of the inline element, and no extra space above or below it.

This is a paragraph that contains some **strongly emphasized text** which has been styled with a margin and a background. This can affect the placement of the line break, as explained in the text.

**Figure 5-71.** An inline nonreplaced element with 25-pixel side margins

Now, when an inline nonreplaced element stretches across multiple lines, the situation changes. [Figure 5-72](#) shows what happens when an inline nonreplaced element with a margin is displayed across multiple lines:

```
strong {margin: 25px; background: silver;}
```

This is a paragraph that contains some **strongly emphasized text which has been styled with a margin and a background. This can affect the placement of the line break**, as explained in the text.

**Figure 5-72.** An inline nonreplaced element with 25-pixel side margin displayed across two lines of text

The left margin is applied to the beginning of the element and the right margin to the end of it. Margins are *not* applied to the right and left side of each line fragment. Also, you can see that, if not for the margins, the line may have broken after “text” instead of after “strongly emphasized.” Margins only affect line-breaking by changing the point at which the element’s content begins within a line.

**Note**

The way margins are (or aren’t) applied to the ends of each line box can be altered with the property `box-decoration-break`.

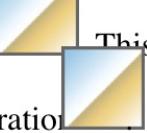
The situation gets even more interesting when we apply negative margins to inline nonreplaced elements. The top and bottom of the element aren’t affected, and neither are the heights of lines, but the left and right ends of the element can overlap other content, as depicted in [Figure 5-73](#):

```
strong {margin: -25px; background: silver;}
```

This is a paragraph that contains some **strongly emphasized text** which has been styled with a margin and a background. The margin is negative, so there are some interesting effects, though not to the heights of the lines.

**Figure 5-73.** An inline nonreplaced element with a negative margin

Replaced inline elements represent yet another story: margins set for them *do* affect the height of a line, either increasing or reducing it depending on the value for the top and bottom margin. The left and right margins of an inline replaced element act the same as for a nonreplaced element. [Figure 5-74](#) shows a series of different effects on layout from margins set on inline replaced elements.

This paragraph contains a bunch of images in the text  , as you can see. Each one has different margins  . Some of these margins are negative,  and some are positive  . Since replaced element boxes affect line height, the margins on these images can alter the amount of space between baselines of text  . This is to be expected, and is something authors must take into consideration.

**Figure 5-74.** Inline replaced elements with differing margin values

# Summary

The ability to apply margins, borders, and padding to any element is one of the things that sets CSS so far above traditional web markup. In the past, enclosing a heading in a colored, bordered box meant wrapping the heading in a table, which is a really bloated and awful way to create so simple an effect. It is this sort of power that makes CSS so compelling.

# Chapter 6. Positioning

The idea behind positioning is fairly simple. It allows you to define exactly where element boxes will appear relative to where they would ordinarily be—or position them in relation to a parent element, another element, or even to the viewport (e.g., the browser window) itself.

# **Basic Concepts**

Before we delve into the various kinds of positioning, it's a good idea to look at what types exist and how they differ. We'll also need to define some basic ideas that are fundamental to understanding how positioning works.

# Types of Positioning

You can choose one of five different types of positioning, which affect how the element's box is generated, by using the `position` property.

## `position`

**Values:** `static` | `relative` | `sticky` | `absolute` | `fixed` | `inherit`

**Initial value:** `static`

**Applies to:** All elements

**Inherited:** No

**Computed value:** As specified

The values of `position` have the following meanings:

### `static`

The element's box is generated as normal. Block-level elements generate a rectangular box that is part of the document's flow, and inline-level boxes cause the creation of one or more line boxes that are flowed within their parent element.

### `relative`

The element's box is offset by some distance. The element retains the shape it would have had were it not positioned, and the space that the

element would ordinarily have occupied is preserved.

#### absolute

The element's box is completely removed from the flow of the document and positioned with respect to its containing block, which may be another element in the document or the initial containing block (described in the next section). Whatever space the element might have occupied in the normal document flow is closed up, as though the element did not exist. The positioned element generates a block-level box, regardless of the type of box it would have generated if it were in the normal flow.

#### fixed

The element's box behaves as though it was set to `absolute`, but its containing block is the viewport itself.

#### sticky

The element is left in the normal flow until the conditions that trigger its stickiness come to pass, at which point it is removed from the normal flow but its original space in the normal flow is preserved. It will then act as if absolutely positioned with respect to its containing block. Once the conditions to enforce stickiness are no longer met, the element is returned to the normal flow in its original space.

Don't worry so much about the details right now, as we'll look at each of these kinds of positioning later. Before we do that, we need to discuss containing blocks.

# The Containing Block

In general terms, a *containing block* is the box that contains another element. As an example, in the normal-flow case, the root element (`html` in HTML) is the containing block for the `body` element, which is in turn the containing block for all its children, and so on. When it comes to positioning, the containing block depends entirely on the type of positioning.

For a non-root element whose `position` value is `relative` or `static`, its containing block is formed by the content edge of the nearest block-level, table-cell, or inline-block ancestor box.

For a non-root element that has a `position` value of `absolute`, its containing block is set to the nearest ancestor (of any kind) that has a `position` value other than `static`. This happens as follows:

- If the ancestor is block-level, the containing block is set to be that element's padding edge; in other words, the area that would be bounded by a border.
- If the ancestor is inline-level, the containing block is set to the content edge of the ancestor. In left-to-right languages, the top and left of the containing block are the top and left content edges of the first box in the ancestor, and the bottom and right edges are the bottom and right content edges of the last box. In right-to-left languages, the right edge of the containing block corresponds to the right content edge of the first box, and the left is taken from the last box. The top and bottom are the same.
- If there are no ancestors, then the element's containing block is defined to be the initial containing block.

There's an interesting variant to the containing-block rules when it comes to sticky-positioned elements, which is that a rectangle is defined in relation to the containing block called the *sticky-constraint rectangle*. This rectangle has everything to do with how sticky positioning works, and will be explained in

full later, in “[Sticky Positioning](#)”.

An important point: positioned elements can be positioned outside of their containing block. This is very similar to the way in which floated elements can use negative margins to float outside of their parent’s content area. It also suggests that the term “containing block” should really be “positioning context,” but since the specification uses “containing block,” so will I. (I do try to minimize confusion. Really!)

# Offset Properties

Four of the positioning schemes described in the previous section—relative, absolute, sticky, and fixed—use four distinct properties to describe the offset of a positioned element’s sides with respect to its containing block. These four properties, which are referred to as the *offset properties*, are a big part of what makes positioning work.

**top, right, bottom, left**

**Values:** <length> | <percentage> | auto | inherit

**Initial value:** auto

**Applies to:** Positioned elements

**Inherited:** No

**Percentages:** Refer to the height of the containing block for top and bottom, and the width of the containing block for right and left

**Computed value:** For relative or sticky-positioned elements, see the sections on those positioning types. For static elements, auto; for length values, the corresponding absolute length; for percentage values, the specified value; otherwise, auto

These properties describe an offset from the nearest side of the containing

block (thus the term *offset properties*). For example, `top` describes how far the top margin edge of the positioned element should be placed from the top of its containing block. In the case of `top`, positive values move the top margin edge of the positioned element *downward*, while negative values move it *above* the top of its containing block. Similarly, `left` describes how far to the right (for positive values) or left (for negative values) the left margin edge of the positioned element is from the left edge of the containing block. Positive values will shift the margin edge of the positioned element to the right, and negative values will move it to the left.

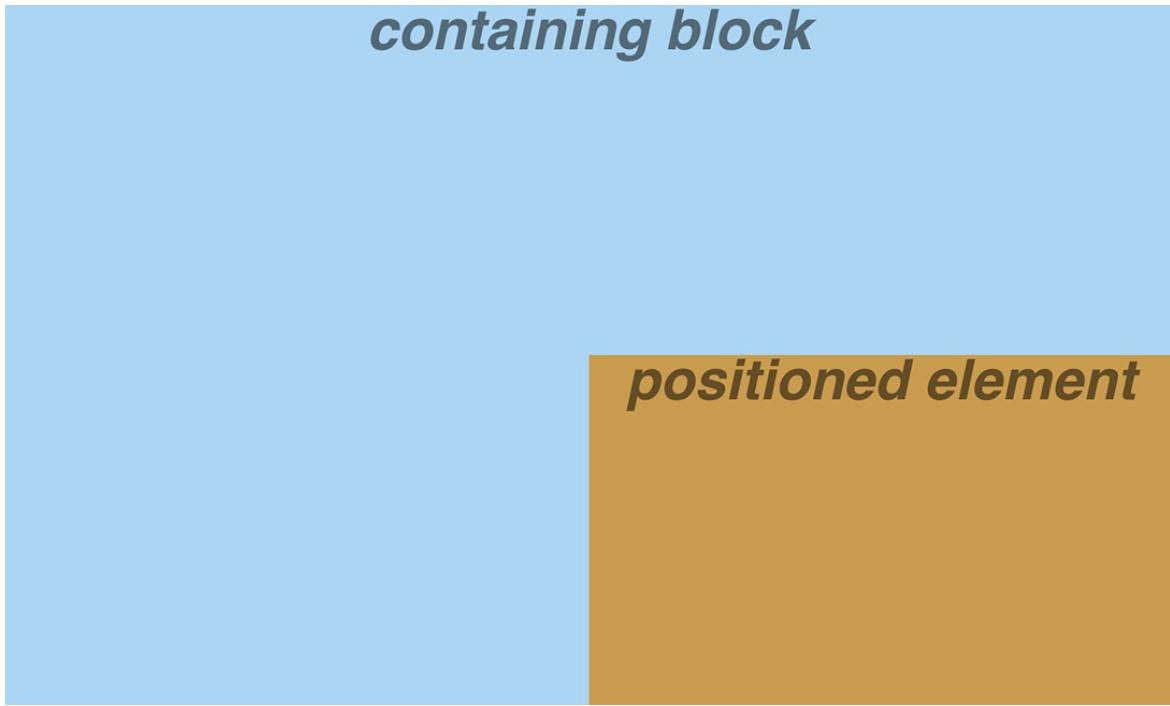
Another way to look at it is that positive values cause inward offsets, moving the edges toward the center of the containing block, and negative values cause outward offsets.

The implication of offsetting the margin edges of a positioned element is that everything about an element—margins, borders, padding, and content—is moved in the process[ of positioning the element. Thus, it is possible to set margins, borders, and padding for a positioned element; these will be preserved and kept with the positioned element, and they will be contained within the area defined by the offset properties.

It is important to remember that the offset properties define an offset from the analogous side (e.g., `left` defines the offset from the left side) of the containing block, not from the upper-left corner of the containing block. This is why, for example, one way to fill up the lower-right corner of a containing block is to use these values:

```
top: 50%; bottom: 0; left: 50%; right: 0;
```

In this example, the outer-left edge of the positioned element is placed halfway across the containing block. This is its offset from the left edge of the containing block. The outer-right edge of the positioned element, however, is not offset from the right edge of the containing block, so the two are coincident. Similar reasoning holds true for the top and bottom of the positioned element: the outer-top edge is placed halfway down the containing block, but the outer-bottom edge is not moved up from the bottom. This leads to what's shown in [Figure 6-1](#).



**Figure 6-1.** Filling the lower-right quarter of the containing block

**Note**

What's depicted in [Figure 6-1](#), and in most of the examples in this chapter, is based around absolute positioning. Since absolute positioning is the simplest scheme in which to demonstrate how `top`, `right`, `bottom`, and `left` work, we'll stick to that for now.

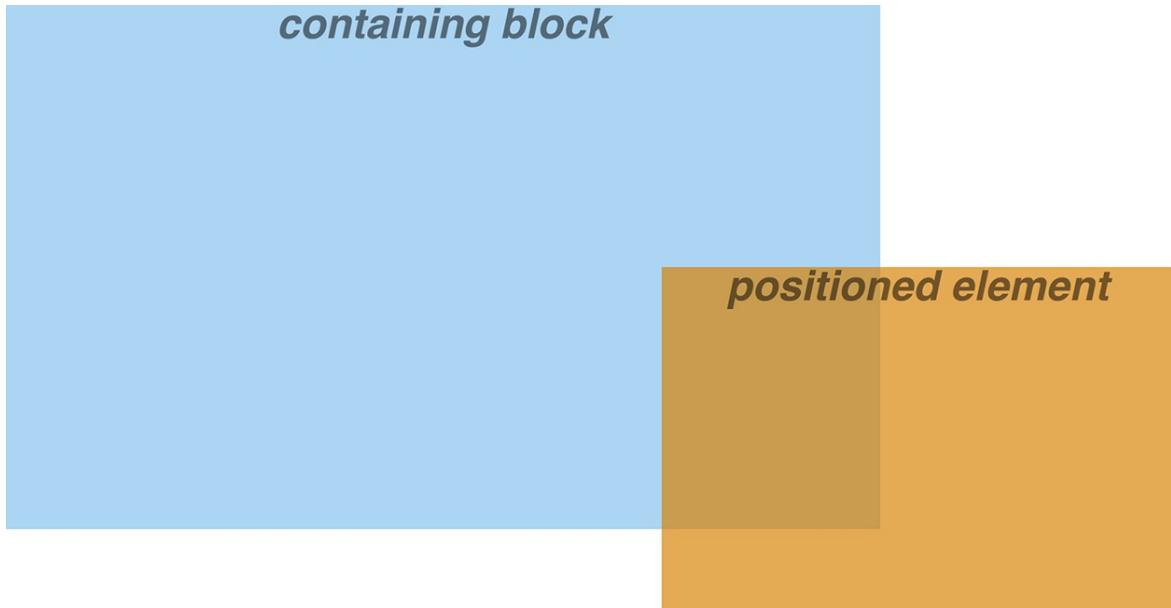
Note the background area of the positioned element. In [Figure 6-1](#), it has no margins, but if it did, they would create blank space between the borders and the offset edges. This would make the positioned element appear as though it did not completely fill the lower-right quarter of the containing block. In truth, it *would* fill the area, but this fact wouldn't be immediately apparent to the eye. Thus, the following two sets of styles would have approximately the same visual appearance, assuming that the containing block is `100em` high by `100em` wide:

```
top: 50%; bottom: 0; left: 50%; right: 0; margin: 10em;  
top: 60%; bottom: 10%; left: 60%; right: 10%; margin: 0;
```

Again, the similarity would be only visual in nature.

By using negative offset values, it is possible to position an element outside its containing block. For example, the following values will lead to the result shown in [Figure 6-2](#):

```
top: 50%; bottom: -2em; left: 75%; right: -7em;
```



**Figure 6-2.** Positioning an element outside its containing block

In addition to length and percentage values, the offset properties can also be set to `auto`, which is the default value. There is no single behavior for `auto`; it changes based on the type of positioning used. We'll explore how `auto` works later on, as we consider each of the positioning types in turn.

# Width and Height

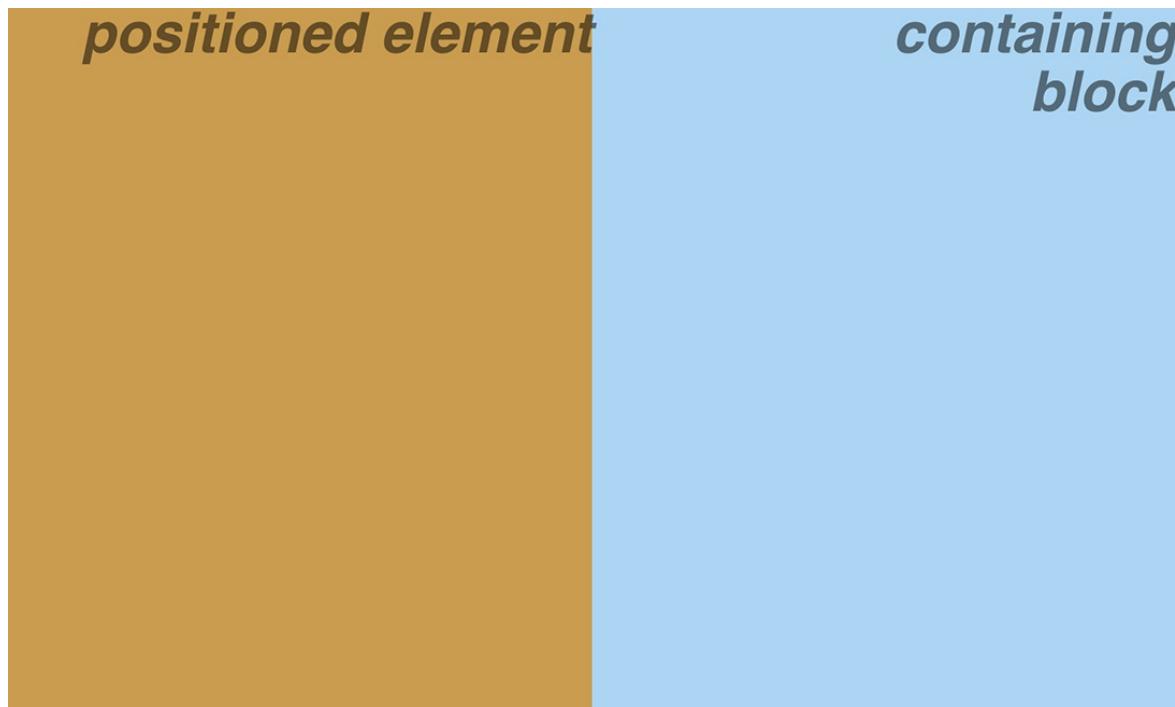
There will be many cases when, having determined where you're going to position an element, you will want to declare how wide and how high that element should be. In addition, there will likely be conditions where you'll want to limit how high or wide a positioned element gets, not to mention cases where you want the browser to go ahead and automatically calculate the width, height, or both.

# Setting Width and Height

If you want to give your positioned element a specific width, then the obvious property to turn to is `width`. Similarly, `height` will let you declare a specific height for a positioned element.

Although it is sometimes important to set the `width` and `height` of an element, it is not always necessary when positioning elements. For example, if the placement of the four sides of the element is described using `top`, `right`, `bottom`, and `left`, then the `height` and `width` of the element are implicitly determined by the offsets. Assume that we want an absolutely positioned element to fill the left half of its containing block, from top to bottom. We could use these values, with the result depicted in [Figure 6-3](#):

```
top: 0; bottom: 0; left: 0; right: 50%;
```



**Figure 6-3.** Positioning and sizing an element using only the offset properties

Since the default value of both `width` and `height` is `auto`, the result shown in

[Figure 6-3](#) is exactly the same as if we had used these values:

```
top: 0; bottom: 0; left: 0; right: 50%; width: 50%; height: 100%;
```

The presence of `width` and `height` in this example add nothing to the layout of the element.

Of course, if we were to add padding, a border, or a margin to the element, then the presence of explicit values for `height` and `width` could very well make a difference:

```
top: 0; bottom: 0; left: 0; right: 50%; width: 50%; height: 100%;  
padding: 2em;
```

This will give us a positioned element that extends out of its containing block, as shown in [Figure 6-4](#).

This happens because (by default) the padding is added to the content area, and the content area's size is determined by the values of `height` and `width`. In order to get the padding we want and still have the element fit inside its containing block, we would either remove the `height` and `width` declarations, explicitly set them both to `auto`, or set `box-sizing` to `border-box`.

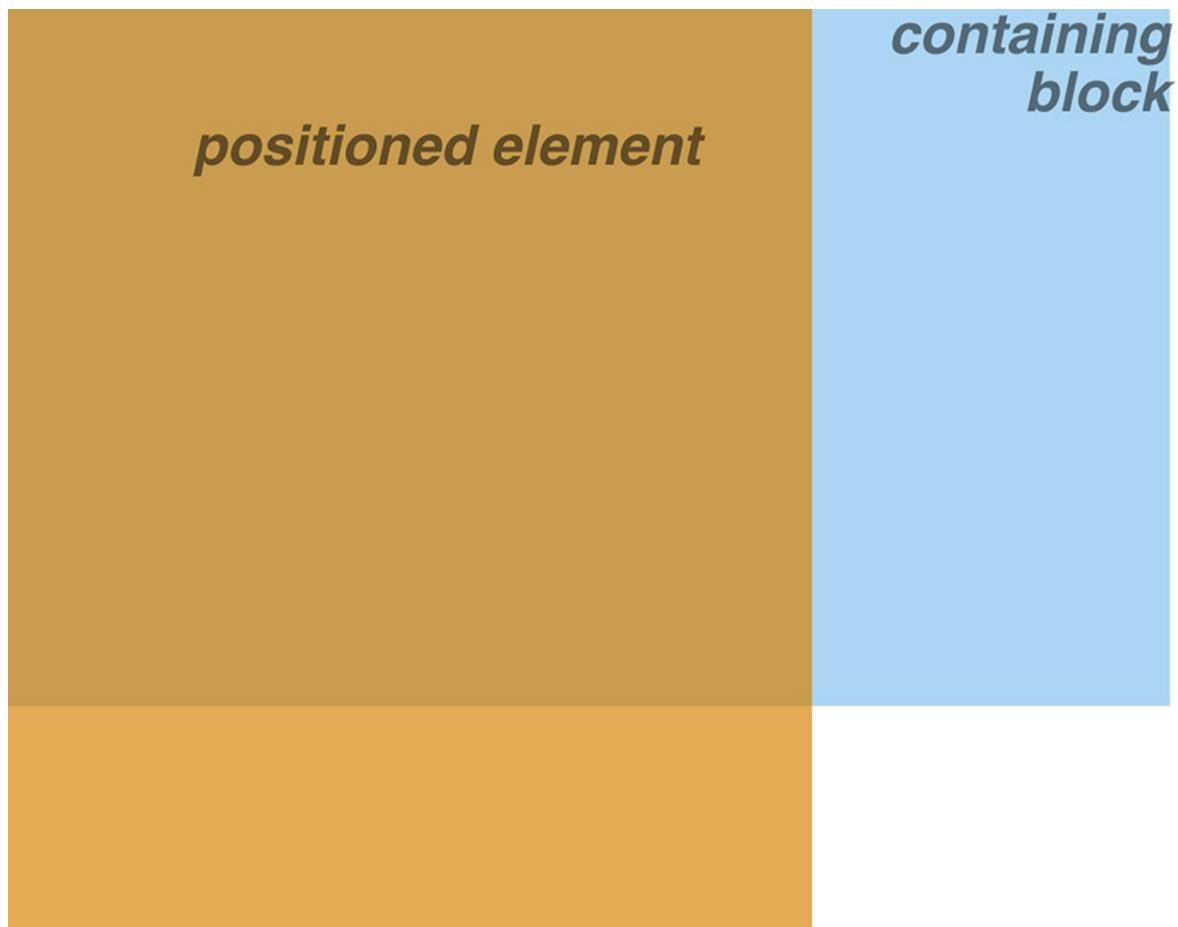


Figure 6–4. Positioning an element partially outside its containing block

# Limiting Width and Height

Should it become necessary or desirable, you can place limits on an element's width by using the following properties, which I'll refer to as the *min-max properties*. An element's content area can be defined to have minimum dimensions using `min-width` and `min-height`.

## **min-width, min-height**

**Values:**     `<length>` | `<percentage>` | `inherit`

**Initial value:** `0`

**Applies to:** All elements except nonreplaced inline elements and table elements

**Inherited:** No

**Percentages:** Refer to the width of the containing block

**Computed value:** For percentages, as specified; for length values, the absolute length; otherwise, none

Similarly, an element's dimensions can be limited using the properties `max-width` and `max-height`.

## **max-width, max-height**

**Values:** <length> | <percentage> | none | inherit

**Initial value:** none

**Applies to:** All elements except nonreplaced inline elements and table elements

**Inherited:** No

**Percentages:** Refer to the height of the containing block

**Computed value:** For percentages, as specified; for length values, the absolute length; otherwise, none

The names of these properties make them fairly self-explanatory. What's less obvious at first, but makes sense once you think about it, is that values for all these properties cannot be negative.

The following styles will force the positioned element to be at least 10em wide by 20em tall, as illustrated in [Figure 6-5](#):

```
top: 10%; bottom: 20%; left: 50%; right: 10%;  
min-width: 10em; min-height: 20em;
```

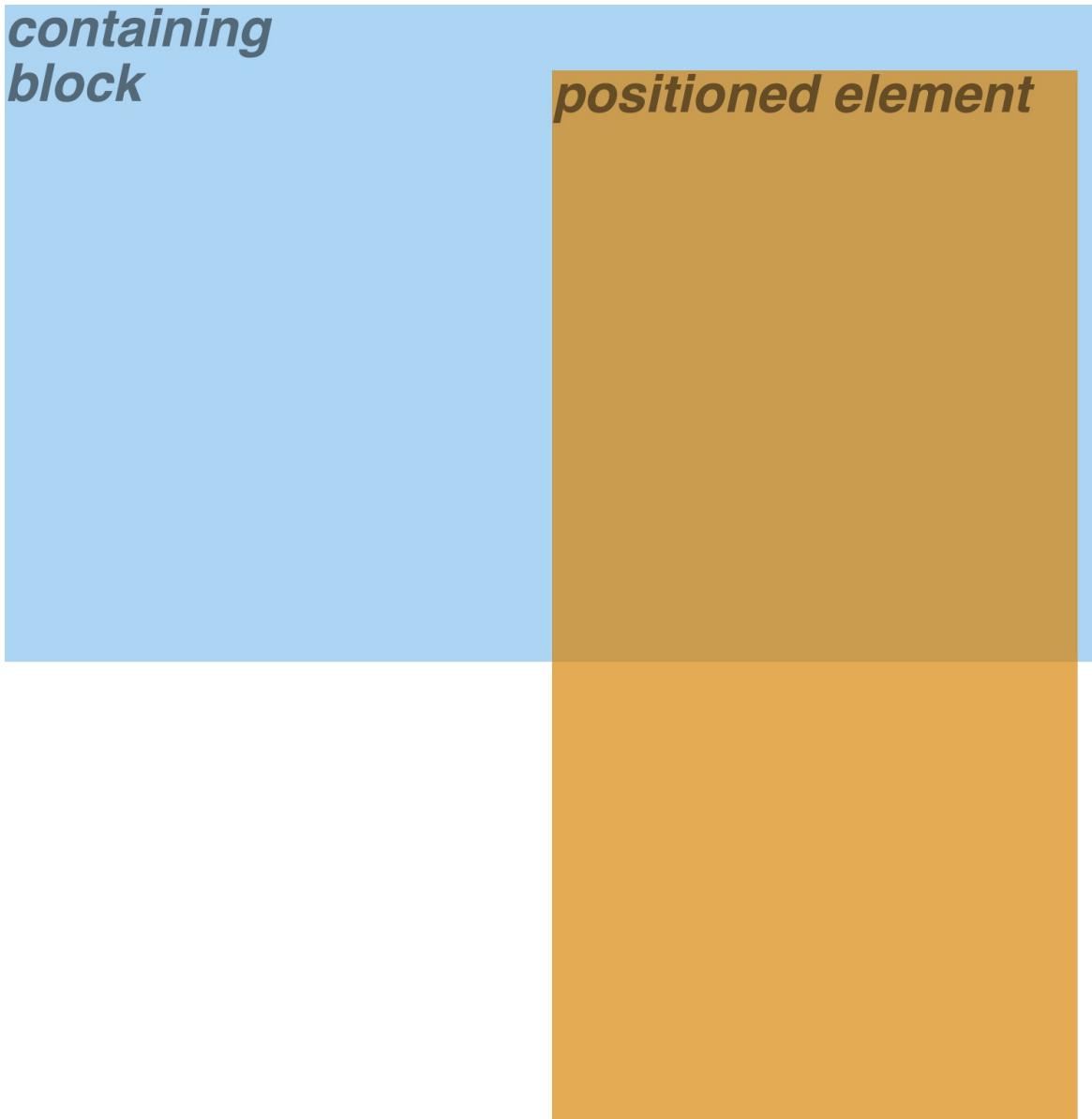


Figure 6-5. Setting a minimum width and height for a positioned element

This isn't a very robust solution since it forces the element to be at least a certain size regardless of the size of its containing block. Here's a better one:

```
top: 10%; bottom: auto; left: 50%; right: 10%;  
height: auto; min-width: 15em;
```

Here we have a case where the element should be 40% as wide as the containing block but can never be less than `15em` wide. We've also changed the `bottom` and `height` so that they're automatically determined. This will let

the element be as tall as necessary to display its content, no matter how narrow it gets (never less than `15em`, of course!).

#### Note

We'll look at the role `auto` plays in the height and width of positioned elements in an upcoming section.

You can turn all this around to keep elements from getting too wide or tall by using `max-width` and `max-height`. Let's consider a situation where, for some reason, we want an element to have three-quarters the width of its containing block but to stop getting wider when it hits 400 pixels. The appropriate styles are:

```
left: 0%; right: auto; width: 75%; max-width: 400px;
```

One great advantage of the min-max properties is that they let you mix units with relative safety. You can use percentage-based sizes while setting length-based limits, or vice versa.

It's worth mentioning that these min-max properties can be very useful in conjunction with floated elements. For example, we can allow a floated element's width to be relative to the width of its parent element (which is its containing block), while making sure that the float's width never goes below `10em`. The reverse approach is also possible:

```
p.aside {float: left; width: 40em; max-width: 40%;}
```

This will set the float to be `40em` wide, unless that would be more than 40% the width of the containing block, in which case the float will be limited to that 40% width.

# **Content Overflow and Clipping**

If the content of an element is too much for the element's size, it will be in danger of overflowing the element itself. There are a few alternatives in such situations, and CSS lets you select among them. It also allows you to define a clipping region to determine the area of the element outside of which these sorts of things become an issue.

# Overflow

So let's say that we have, for whatever reason, an element that has been pinned to a specific size, and the content doesn't fit. You can take control of the situation with the `overflow` property.

## **overflow**

**Values:** `visible | hidden | scroll | auto | inherit`

**Initial value:** `visible`

**Applies to:** Block-level and replaced elements

**Inherited:** No

**Computed value:** As specified

The default value of `visible` means that the element's content may be visible outside the element's box. Typically, this leads to the content simply running outside its own element box but not altering the shape of that box. The following markup would result in [Figure 6-6](#):

```
div#sidebar {position: absolute; top: 0; left: 0; width: 25%; height: 100px; background: #bbb; overflow: visible;}
```

If `overflow` is set to `scroll`, the element's content is clipped—that is, hidden—at the edges of the element box, but there is some way to make the extra content available to the user. In a web browser, this could mean a scroll bar (or set of them), or another method of accessing the content without altering

the shape of the element itself. One possibility is depicted in [Figure 6-7](#), which results from the following markup:

```
div#sidebar {position: absolute; top: 0; left: 0; width: 15%; hei  
overflow: scroll;}
```

If `scroll` is used, the panning mechanisms (e.g., scroll bars) should always be rendered. To quote the specification, “this avoids any problem with scrollbars appearing or disappearing in a dynamic environment.” Thus, even if the element has sufficient space to display all its content, the scroll bars should still appear. In addition, when printing a page or otherwise displaying the document in a print medium, the content may be displayed as though the value of `overflow` were declared to be `visible`.

***This is a positioned element that's acting as a ‘sidebar’, but it's only 7em tall. Any overflowing content won't be visible outside the boundaries of the element box, whether or not that's what the author really wanted.***

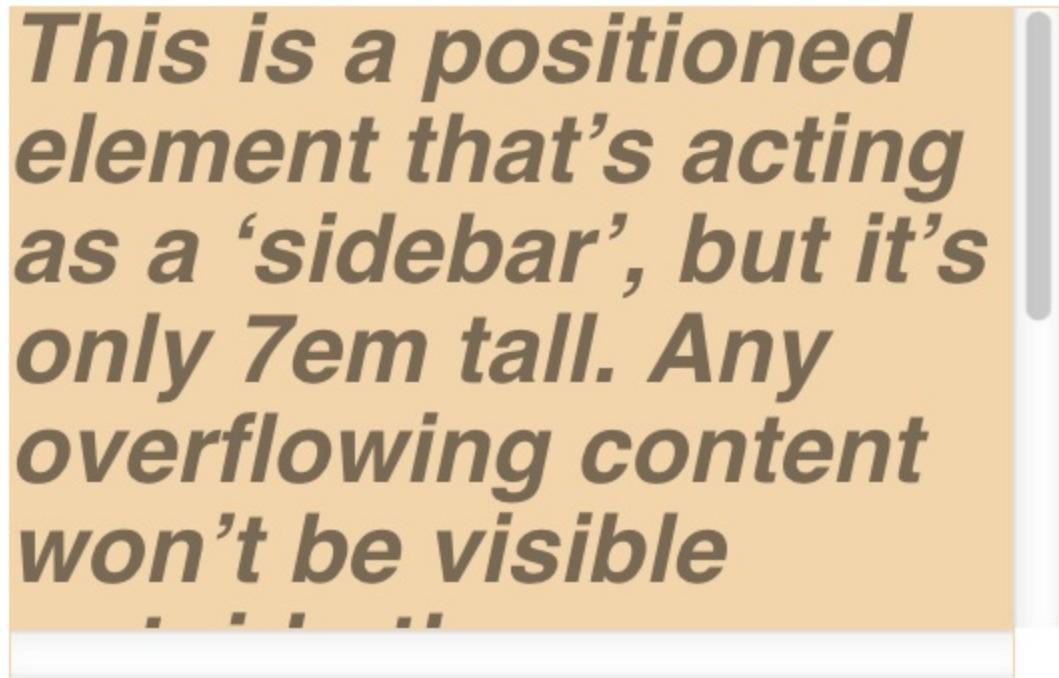
**Figure 6-6. Content visibly overflowing the element box**

If `overflow` is set to `hidden`, the element's content is clipped at the edges of the element box, but no scrolling interface should be provided to make the content outside the clipping region accessible to the user. Consider the following markup:

```
div#sidebar {position: absolute; top: 0; left: 0; width: 15%; hei  
overflow: hidden;}
```

In such an instance, the clipped content would not be accessible to the user.

This would lead to a situation like that illustrated in [Figure 6-8](#).



***This is a positioned element that's acting as a 'sidebar', but it's only 7em tall. Any overflowing content won't be visible***

.....

The image shows a yellow sidebar with a scroll bar on the right. The sidebar contains text about a positioned element acting as a sidebar. At the bottom, there are five ellipsis characters (...).

Figure 6-7. Overflowing content made available via a scroll mechanism

***This is a positioned element that's acting as a ‘sidebar’, but it's only 7em tall. Any overflowing content won't be visible outside the boundaries***

Figure 6-8. Clipping content at the edges of the content area

Finally, there is `overflow: auto`. This allows user agents to determine which behavior to use, although they are encouraged to provide a scrolling mechanism when necessary. This is a potentially useful way to use overflow, since user agents could interpret it to mean “provide scroll bars only when needed.” (They may not, but they certainly could and probably should.)

# Element Visibility

In addition to all the clipping and overflowing, you can also control the visibility of an entire element.

## **visibility**

**Values:** visible | hidden | collapse | inherit

**Initial value:** visible

**Applies to:** All elements

**Inherited:** Yes

**Computed value:** As specified

This one is pretty easy. If an element is set to have `visibility: visible`, then it is, of course, visible. If an element is set to `visibility: hidden`, it is made “invisible” (to use the wording in the specification). In its invisible state, the element still affects the document’s layout as though it were visible. In other words, the element is still there—you just can’t see it, pretty much as if you’d declared `opacity: 0`.

Note the difference between this and `display: none`. In the latter case, the element is not displayed *and* is removed from the document altogether so that it doesn’t have any effect on document layout. [Figure 6-9](#) shows a document in which a paragraph has been set to `hidden`, based on the following styles and markup:

```
em.trans {visibility: hidden; border: 3px solid gray; background:  
margin: 2em; padding: 1em;}  
  
<p>  
This is a paragraph which should be visible. Nulla berea cons  
city, mutationem dolore. <em class="trans">Humanitatis molly  
ut lorem.</em> Doug dieken dolor possim south euclid.  
</p>
```

This is a paragraph which should be visible. Nulla berea consuetudium ohio city, mutationem dolore.

Doug  
dieken dolor possim south euclid.

**Figure 6-9. Making elements invisible without suppressing their element boxes**

Everything visible about a hidden element—such as content, background, and borders—is made invisible. The space is still there because the element is still part of the document’s layout. We just can’t see it.

It’s possible to set the descendant element of a `hidden` element to be `visible`. This causes the element to appear wherever it normally would, despite the fact that the ancestor is invisible. In order to do so, we explicitly declare the descendant element `visible`, since `visibility` is inherited:

```
p.clear {visibility: hidden;}  
p.clear em {visibility: visible;}
```

As for `visibility: collapse`, this value is used in CSS table rendering, which we don’t really have room to cover here. According to the specification, `collapse` has the same meaning as `hidden` if it is used on nontable elements.

# Absolute Positioning

Since most of the examples and figures in the previous sections are examples of absolute positioning, you're already halfway to understanding how it works. Most of what remains are the details of what happens when absolute positioning is invoked.

# Containing Blocks and Absolutely Positioned Elements

When an element is positioned absolutely, it is completely removed from the document flow. It is then positioned with respect to its containing block, and its margin edges are placed using the offset properties (`top`, `left`, etc.). The positioned element does not flow around the content of other elements, nor does their content flow around the positioned element. This implies that an absolutely positioned element may overlap other elements or be overlapped by them. (We'll see how to affect the overlapping order later.)

The containing block for an absolutely positioned element is the nearest ancestor element that has a `position` value other than `static`. It is common for an author to pick an element that will serve as the containing block for the absolutely positioned element and give it a `position` of `relative` with no offsets, like so:

```
.contain {position: relative;}
```

Consider the example in [Figure 6-10](#), which is an illustration of the following:

```
p {margin: 2em;}  
p.contain {position: relative;} /* establish a containing block*/  
b {position: absolute; top: auto; right: 0; bottom: 0; left: auto  
    width: 8em; height: 5em; border: 1px solid gray;}  
  
<body>  
<p>  
    This paragraph does <em>not</em> establish a containing block  
    its descendant elements that are absolutely positioned. There  
    absolutely positioned <b>boldface</b> element it contains wil  
    positioned with respect to the initial containing block.  
</p>  
<p class="contain">  
    Thanks to <code>position: relative</code>, this paragraph est  
    containing block for any of its descendant elements that are  
    positioned. Since there is such an element-- <em>that is to s  
    boldfaced element that is absolutely positioned,</b> placed w
```

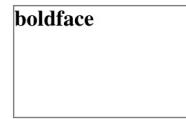
```
to its containing block (the paragraph)</em>, it will appear  
element box generated by the paragraph.
```

```
</p>  
</body>
```

The **b** elements in both paragraphs have been absolutely positioned. The difference is in the containing block used for each one. The **b** element in the first paragraph is positioned with respect to the initial containing block, because all of its ancestor elements have a position of static. The second paragraph has been set to position: relative, so it establishes a containing block for its descendants.

This paragraph does *not* establish a containing block for any of its descendant elements that are absolutely positioned. Therefore, the absolutely positioned element it contains will be positioned with respect to the initial containing block.

Thanks to position: relative, this paragraph establishes a containing block for any of its descendant elements that are absolutely positioned. Since that is such an element-- *that is to say, placed with respect to its containing block (the paragraph)*, it will appear within the element box generated by the paragraph.



**Figure 6-10. Using relative positioning to define containing blocks**

You've probably noted that in that second paragraph, the positioned element overlaps some of the text content of the paragraph. There is no way to avoid this, short of positioning the **b** element outside of the paragraph (by using a negative value for `right` or one of the other offset properties) or by specifying a padding for the paragraph that is wide enough to accommodate the positioned element. Also, since the **b** element has a transparent background, the paragraph's text shows through the positioned element. The only way to avoid this is to set a background for the positioned element, or else move it out of the paragraph entirely.

You will sometimes want to ensure that the `body` element establishes a containing block for all its descendants, rather than allowing the user agent to pick an initial containing block. This is as simple as declaring:

```
body {position: relative;}
```

In such a document, you could drop in an absolutely positioned paragraph, as follows, and get a result like that shown in [Figure 6-11](#):

```
<p style="position: absolute; top: 0; right: 25%; left: 25%; bottom: auto; width: 50%; height: auto; background: silver;">  
    ...  
</p>
```

The paragraph is now positioned at the very beginning of the document, half as wide as the document's width and overwriting other content.

Once the competition begins, it could be worse. Just imagine if she were alone, and they never notice the facial color or were a proctologist. They're trapped at a midwifery party when the games begin. They just keep topping each other with tales of pregnancies with more complications and bigger emergencies, as though it were the most natural thing in the world, until the stories involve more gore and slime than any three David Cronenberg movies put together, with a little bit of "Alien" thrown in for good measure. And then you get to the *really* icky stories.

**Figure 6-11. Positioning an element whose containing block is the root element**

An important point to highlight is that when an element is absolutely positioned, it establishes a containing block for its descendant elements. For example, we can absolutely position an element and then absolutely position one of its children, as shown in [Figure 6-12](#), which was generated using the following styles and basic markup:

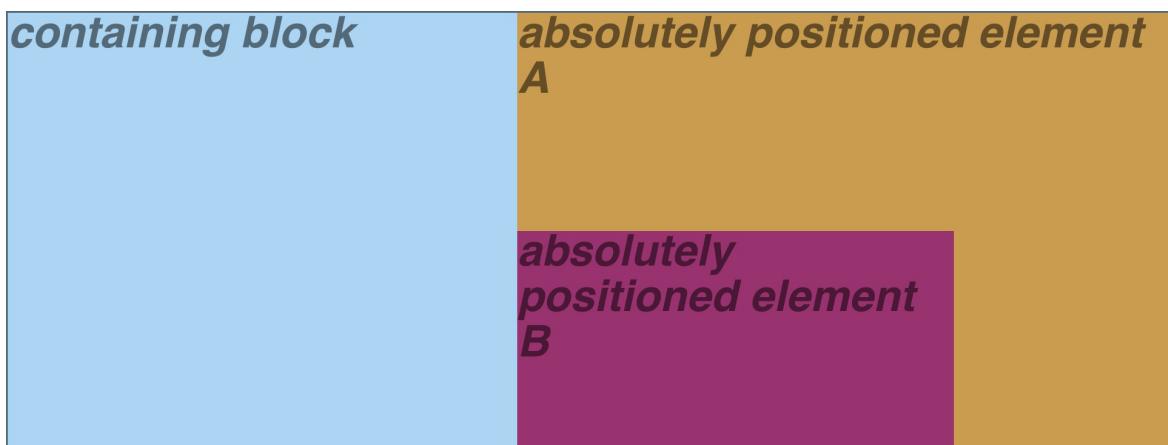
```
div {position: relative; width: 100%; height: 10em;  
    border: 1px solid; background: #EEE;}  
div.a {position: absolute; top: 0; right: 0; width: 15em; height:  
    margin-left: auto; background: #CCC;}  
div.b {position: absolute; bottom: 0; left: 0; width: 10em; height:  
    margin-top: auto; background: #AAA;}  
  
<div>  
    <div class="a">  
        absolutely positioned element A  
        <div class="b">  
            absolutely positioned element B  
        </div>  
    </div>  
    containing block
```

```
</div>
```

Remember that if the document is scrolled, the absolutely positioned elements will scroll right along with it. This is true of all absolutely positioned elements that are not descendants of fixed-position or sticky-position elements.

This happens because, eventually, the elements are positioned in relation to something that's part of the normal flow. For example, if you absolutely position a table, and its containing block is the initial containing block, then it will scroll because the initial containing block is part of the normal flow, and thus it scrolls.

If you want to position elements so that they're placed relative to the viewport and don't scroll along with the rest of the document, keep reading. The upcoming section on fixed positioning has the answers you seek.



**Figure 6-12. Absolutely positioned elements establish containing blocks**

# Placement and Sizing of Absolutely Positioned Elements

It may seem odd to combine the concepts of placement and sizing, but it's a necessity with absolutely positioned elements because the specification binds them very closely together. This is not such a strange pairing upon reflection. Consider what happens if an element is positioned using all four offset properties, like so:

```
#masthead h1 {position: absolute; top: 1em; left: 1em; right: 25%  
margin: 0; padding: 0; background: silver;}
```

Here, the height and width of the `h1`'s element box is determined by the placement of its outer margin edges, as shown in [Figure 6-13](#).

If the containing block were made taller, then the `h1` would also become taller; if the containing block is narrowed, then the `h1` will become narrower. If we were to add margins or padding to the `h1`, then that would have further effects on the calculated height and width of the `h1`.



**Figure 6-13.** Determining the height of an element based on the offset properties

But what if we do all that and then also try to set an explicit height and width?:

```
#masthead h1 {position: absolute; top: 0; left: 1em; right: 10%;  
height: 100px; width: 100px; background-color: red; color: white;}
```

```
margin: 0; padding: 0; height: 1em; width: 50%; background: s
```

Something has to give, because it's incredibly unlikely that all those values will be accurate. In fact, the containing block would have to be exactly two and a half times as wide as the `h1`'s computed value for `font-size` for all of the shown values to be accurate. Any other `width` would mean at least one value is wrong and has to be ignored. Figuring out which one depends on a number of factors, and the factors change depending on whether an element is replaced or nonreplaced.

For that matter, consider the following:

```
#masthead h1 {position: absolute; top: auto; left: auto;}
```

What should the result be? As it happens, the answer is *not* "reset the values to zero." We'll see the actual answer, starting in the next section.

# Auto-edges

When absolutely positioning an element, there is a special behavior that applies when any of the offset properties other than `bottom` is set to `auto`. Let's take `top` as an example. Consider the following:

```
<p>
```

When we consider the effect of positioning, it quickly becomes clear that authors can do a great deal of damage to layout, just as they can with interesting things.<span style="position: absolute; top: auto; left: 0; ">[4]</span> This is usually the case with useful techniques: the sword always has at least two edges, both of them sharp.

```
</p>
```

What should happen? For `left`, it's easy: the left edge of the element should be placed against the left edge of its containing block (which we'll assume here to be the initial containing block). For `top`, however, something much more interesting happens. The top of the positioned element should line up with the place where its top would have been if it were not positioned at all. In other words, imagine where the `span` would have been placed if its `position` value were `static`; this is its *static position*—the place where its top edge should be calculated to sit. CSS 2.1 had this to say about static positions:

the term “static position” (of an element) refers, roughly, to the position an element would have had in the normal flow. More precisely: the static position for `top` is the distance from the top edge of the containing block to the top margin edge of a hypothetical box that would have been the first box of the element if its specified `position` value had been `static` and its specified `float` had been `none` and its specified `clear` had been `none`... The value is negative if the hypothetical box is above the containing block.

Therefore, we should get the result shown in [Figure 6-14](#).

When we consider the effect of positioning, it quickly becomes clear that authors can do a great deal of damage to layout, just as they can do very interesting things. This is usually the case with useful technologies: the sword always has at least two edges, both of them sharp.

[4]

**Figure 6-14. Absolutely positioning an element consistently with its “static” top edge**

The “[4]” sits just outside the paragraph’s content because the initial containing block’s left edge is to the left of the paragraph’s left edge.

The same basic rules hold true for `left` and `right` being set to `auto`. In those cases, the left (or right) edge of a positioned element lines up with the spot where the edge would have been placed if the element weren’t positioned. So let’s modify our previous example so that both `top` and `left` are set to `auto`:

```
<p>
  When we consider the effect of positioning, it quickly become
  authors can do a great deal of damage to layout, just as they
  interesting things.<span style="position: absolute; top: auto
  auto;">[4]</span> This is usually the case with useful techno
  the sword always has at least two edges, both of them sharp.
</p>
```

This would have the result shown in [Figure 6-15](#).

When we consider the effect of positioning, it quickly becomes clear that authors can do a great deal of damage to layout, just as they can do very interesting things.[**4**] This is usually the case with useful technologies: the sword always has at least two edges, both of them sharp.

**Figure 6-15. Absolutely positioning an element consistently with its “static” position**

The “[4]” now sits right where it would have were it not positioned. Note that, since it is positioned, its normal-flow space is closed up. This causes the positioned element to overlap the normal-flow content.

This auto-placement works only in certain situations, generally wherever there are few constraints on the other dimensions of a positioned element. Our previous example could be auto-placed because it had no constraints on its height or width, nor on the placement of the bottom and right edges. But suppose, for some reason, there had been such constraints. Consider:

<p>

When we consider the effect of positioning, it quickly becomes clear that authors can do a great deal of damage to layout, just as they can with interesting things.<span style="position: absolute; top: auto; right: 0; bottom: 0; height: 2em; width: 5em;">[4]</span> This is the case with useful technologies: the sword always has at least one of them sharp.

</p>

It is not possible to satisfy all of those values. Determining what happens is the subject of the next section.

# Placing and Sizing Nonreplaced Elements

In general, the size and placement of an element depends on its containing block. The values of its various properties (`width`, `right`, `padding-left`, and so on) affect its layout, of course, but the foundation is the containing block.

Consider the width and horizontal placement of a positioned element. It can be represented as an equation which states:

$$\text{left} + \text{margin-left} + \text{border-left-width} + \text{padding-left} + \text{width} + \text{padding-right} + \text{border-right-width} + \text{margin-right} + \text{right} = \text{the width of the containing block}$$

This calculation is fairly reasonable. It's basically the equation that determines how block-level elements in the normal flow are sized, except it adds `left` and `right` to the mix. So how do all these interact? There is a series of rules to work through.

First, if `left`, `width`, and `right` are all set to `auto`, then you get the result seen in the previous section: the left edge is placed at its static position, assuming a left-to-right language. In right-to-left languages, the right edge is placed at its static position. The width of the element is set to be "shrink to fit," which means the element's content area is made only as wide as necessary to contain its content. The nonstatic position property (`right` in left-to-right languages, `left` in right-to-left) is set to take up the remaining distance. For example:

```
<div style="position: relative; width: 25em; border: 1px dotted;">  
  An absolutely positioned element can have its content <span style="position: absolute; top: 0; left: 0; right: auto; width: auto; background-color: silver;">shrink-wrapped</span> thanks to the way positioning  
</div>
```

This has the result shown in [Figure 6-16](#).

shrink-wrapped positioned element can have its content thanks to the way positioning rules work.

**Figure 6-16. The “shrink-to-fit” behavior of absolutely positioned elements**

The top of the element is placed against the top of its containing block (the `div`, in this case), and the width of the element is just as much as is needed to contain the content. The remaining distance from the right edge of the element to the right edge of the containing block becomes the computed value of `right`.

Now suppose that only the left and right margins are set to `auto`, not `left`, `width`, and `right`, as in this example:

```
<div style="position: relative; width: 25em; border: 1px dotted;">  
    An absolutely positioned element can have its content <span s  
    absolute; top: 0; left: 1em; right: 1em; width: 10em; margin:  
    background: silver;">shrink-wrapped</span> thanks to the way  
    rules work.  
</div>
```

What happens here is that the left and right margins, which are both `auto`, are set to be equal. This will effectively center the element, as shown in [Figure 6-17](#).

An absolutely positioned element can have its content thanks to the way positioning rules work.

**Figure 6-17. Horizontally centering an absolutely positioned element with auto margins**

This is basically the same as auto-margin centering in the normal flow. So let's make the margins something other than `auto`:

```
<div style="position: relative; width: 25em; border: 1px dotted;">  
    An absolutely positioned element can have its content <span s  
    absolute; top: 0; left: 1em; right: 1em; width: 10em; margin-  
    margin-right: 1em; background: silver;">shrink-wrapped</span>  
    way positioning rules work.  
</div>
```

Now we have a problem. The positioned `span`'s properties add up to only `14em`, whereas the containing block is `25em` wide. That's an 11-em deficit we have to make up somewhere.

The rules state that, in this case, the user agent ignores the value for `right` (in left-to-right languages; otherwise, it ignores `left`) and solves for it. In other words, the result will be the same as if we'd declared:

```
<span style="position: absolute; top: 0; left: 1em;  
right: 12em; width: 10em; margin-left: 1em; margin-right: 1em;  
right: auto; background: silver;">shrink-wrapped</span>
```

This has the result shown in [Figure 6-18](#).

An alshrink-wrapped element can have its content thanks to the way positioning rules work.

**Figure 6-18. Ignoring the value for right in an overconstrained situation**

If one of the margins had been `left` as `auto`, then that would have been changed instead. Suppose we change the styles to state:

```
<span style="position: absolute; top: 0; left: 1em;  
right: 1em; width: 10em; margin-left: 1em; margin-right: auto;  
background: silver;">shrink-wrapped</span>
```

The visual result would be the same as that in [Figure 6-18](#), only it would be attained by computing the right margin to `12em` instead of overriding the value assigned to the property `right`.

If, on the other hand, we made the left margin `auto`, then *it* would be reset, as illustrated in [Figure 6-19](#):

```
<span style="position: absolute; top: 0; left: 1em;  
right: 1em; width: 10em; margin-left: auto; margin-right: 1em;  
background: silver;">shrink-wrapped</span>
```

An absolutely positioned elements shrink-wrapped to the way positioning rules work.

**Figure 6-19. Ignoring the value for margin-right in an overconstrained situation**

In general, if only one of the properties is set to `auto`, then it will be used to

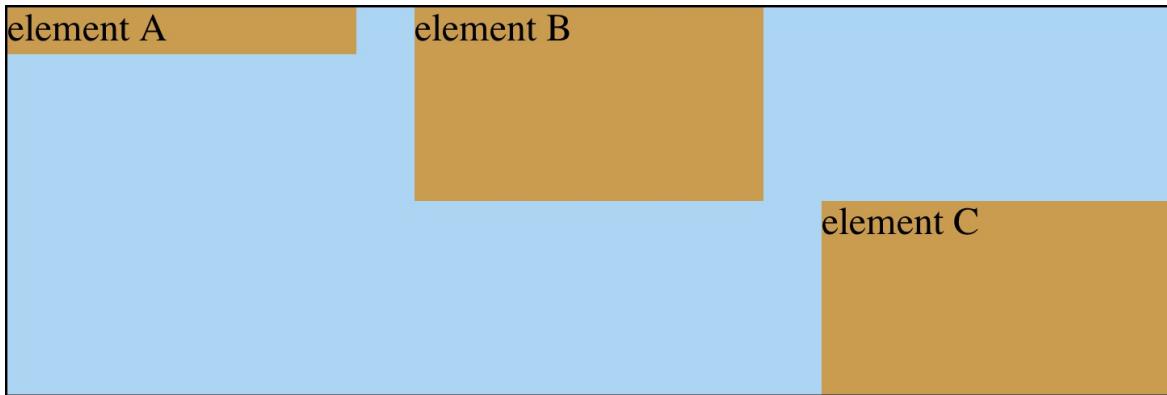
satisfy the equation given earlier in the section. Thus, given the following styles, the element's width would expand to whatever size is needed, instead of “shrink-wrapping” the content:

```
<span style="position: absolute; top: 0; left: 1em;  
right: 1em; width: auto; margin-left: 1em; margin-right: 1em;  
background: silver;">not shrink-wrapped</span>
```

So far we've really only examined behavior along the horizontal axis, but very similar rules hold true along the vertical axis. If we take the previous discussion and rotate it 90 degrees, as it were, we get almost the same behavior. For example, the following markup results in [Figure 6-20](#):

```
<div style="position: relative; width: 30em; height: 10em; border  
    <div style="position: absolute; left: 0; width: 30%;  
        background: #CCC; top: 0;">  
            element A  
    </div>  
    <div style="position: absolute; left: 35%; width: 30%;  
        background: #AAA; top: 0; height: 50%;">  
            element B  
    </div>  
    <div style="position: absolute; left: 70%; width: 30%;  
        background: #CCC; height: 50%; bottom: 0;">  
            element C  
    </div>  
</div>
```

In the first case, the height of the element is shrink-wrapped to the content. In the second, the unspecified property (`bottom`) is set to make up the distance between the bottom of the positioned element and the bottom of its containing block. In the third case, `top` is unspecified, and therefore used to make up the difference.



**Figure 6-20.** Vertical layout behavior for absolutely positioned elements

For that matter, auto-margins can lead to vertical centering. Given the following styles, the absolutely positioned `div` will be vertically centered within its containing block, as shown in [Figure 6-21](#):

```
<div style="position: relative; width: 10em; height: 10em; border
    <div style="position: absolute; left: 0; width: 100%; backgro
        top: 0; height: 5em; bottom: 0; margin: auto 0;">
            element D
    </div>
</div>
```

There are two small variations to point out. In horizontal layout, either `right` or `left` can be placed according to the static position if their values are `auto`. In vertical layout, only `top` can take on the static position; `bottom`, for whatever reason, cannot.

Also, if an absolutely positioned element's size is overconstrained in the vertical direction, `bottom` is ignored. Thus, in the following situation, the declared value of `bottom` would be overridden by the calculated value of `5em`:

```
<div style="position: relative; width: 10em; height: 10em; border
    <div style="position: absolute; left: 0; width: 100%; backgro
        top: 0; height: 5em; bottom: 0; margin: 0;">
            element D
    </div>
</div>
```

There is no provision for `top` to be ignored if the properties are overconstrained.

# Placing and Sizing Replaced Elements

Positioning rules are different for replaced elements (e.g., images) than they are for nonreplaced elements. This is because replaced elements have an intrinsic height and width, and therefore are not altered unless explicitly changed by the author. Thus, there is no concept of “shrink to fit” in the positioning of replaced elements.

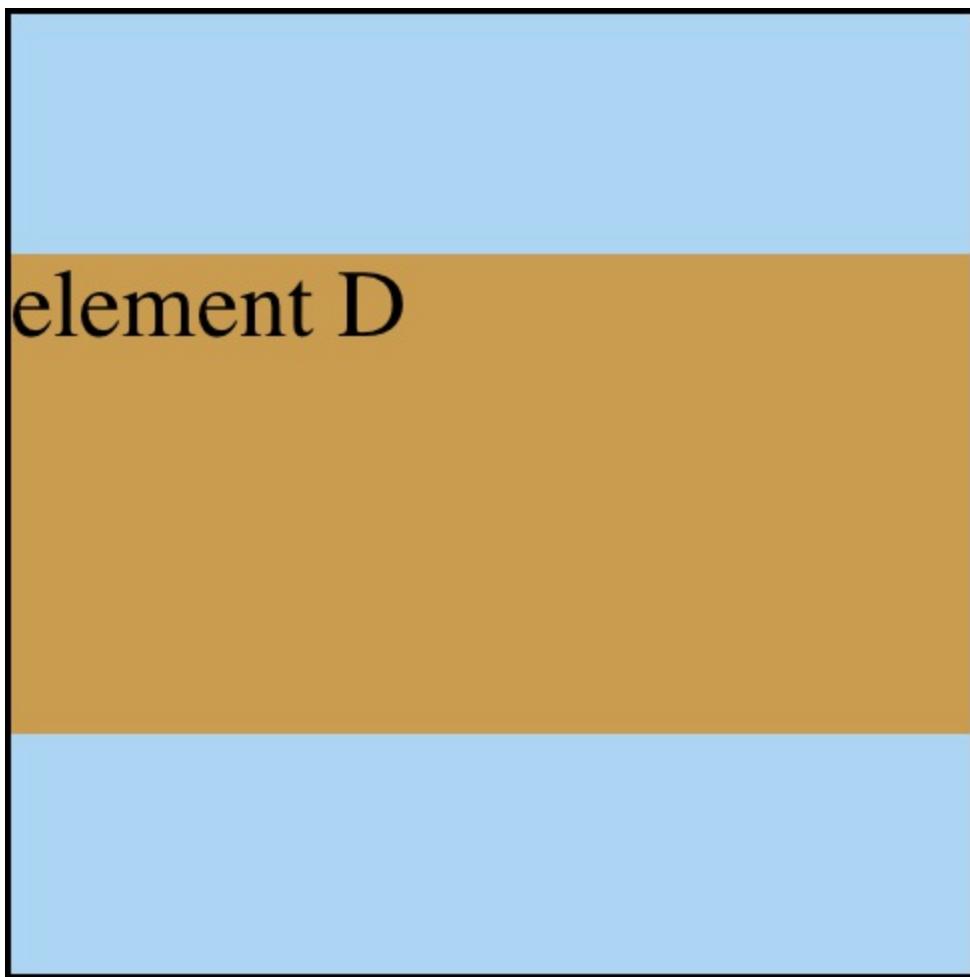


Figure 6-21. Vertically centering an absolutely positioned element with auto-margins

The behaviors that go into placing and sizing replaced elements are most easily expressed by a series of rules to be taken one after the other. These state:

1. If `width` is set to `auto`, the used value of `width` is determined by the intrinsic width of the element's content. Thus, if an image is intrinsically 50 pixels wide, then the used value is calculated to be `50px`. If `width` is explicitly declared (that is, something like `100px` or `50%`), then the width is set to that value.
2. If `left` has the value `auto` in a left-to-right language, replace `auto` with the static position. In right-to-left languages, replace an `auto` value for `right` with the static position.
3. If either `left` or `right` is still `auto` (in other words, it hasn't been replaced in a previous step), replace any `auto` on `margin-left` or `margin-right` with `0`.
4. If, at this point, both `margin-left` and `margin-right` are still defined to be `auto`, set them to be equal, thus centering the element in its containing block.
5. After all that, if there is only one `auto` value left, change it to equal the remainder of the equation.

This leads to the same basic behaviors we saw with absolutely positioned nonreplaced elements, as long as you assume that there is an explicit `width` for the nonreplaced element. Therefore, the following two elements will have the same width and placement, assuming the image's intrinsic width is 100 pixels (see [Figure 6-22](#)):

```
<div>
  
<div style="position: absolute; top: 0; left: 50px;
  width: 100px; height: 100px; margin: 0;">
  it's a div!
</div>
```



**Figure 6-22. Absolutely positioning a replaced element**

As with nonreplaced elements, if the values are overconstrained, the user agent is supposed to ignore the value for `right` in left-to-right languages and `left` in right-to-left languages. Thus, in the following example, the declared value for `right` is overridden with a computed value of `50px`:

```
<div style="position: relative; width: 300px;">
  
</div>
```

Similarly, layout along the vertical axis is governed by a series of rules that state:

1. If `height` is set to `auto`, the computed value of `height` is determined by the intrinsic height of the element's content. Thus, the height of an image 50 pixels tall is computed to be `50px`. If `height` is explicitly declared (that is, something like `100px` or `50%`) then the height is set to that value.
2. If `top` has the value `auto`, replace it with the replaced element's static position.

3. If `bottom` has a value of `auto`, replace any `auto` value on `margin-top` or `margin-bottom` with 0.
4. If, at this point, both `margin-top` and `margin-bottom` are still defined to be `auto`, set them to be equal, thus centering the element in its containing block.
5. After all that, if there is only one `auto` value left, change it to equal the remainder of the equation.

As with nonreplaced elements, if the values are overconstrained, then the user agent is supposed to ignore the value for `bottom`.

Thus, the following markup would have the results shown in [Figure 6-23](#):

```
<div style="position: relative; height: 200px; width: 200px; border: 1px solid black;>
  
  
  
  
  
</div>
```

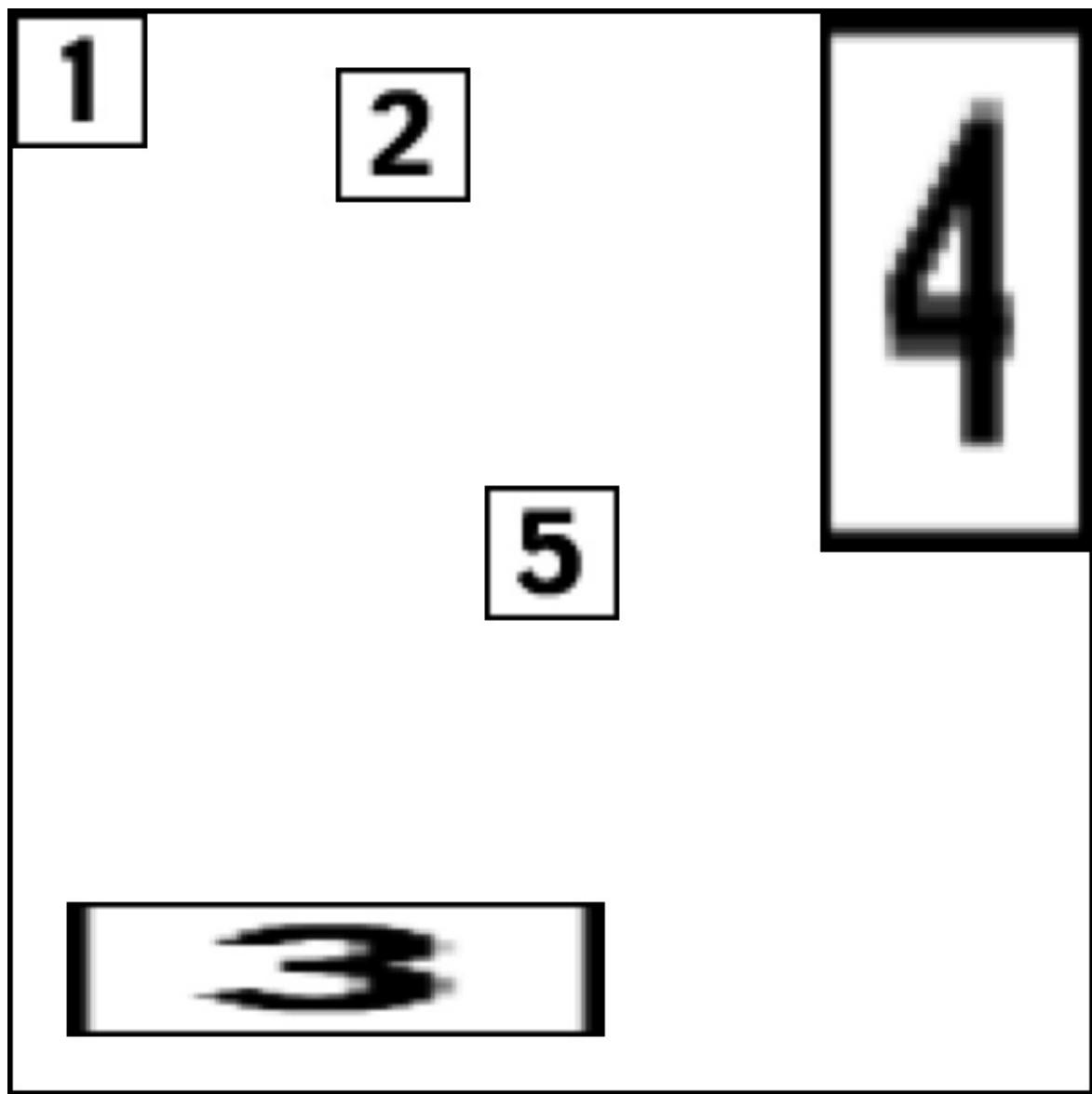


Figure 6-23. Stretching replaced elements through positioning

# Placement on the z-axis

With all of the positioning going on, there will inevitably be a situation where two elements will try to exist in the same place, visually speaking. Obviously, one of them will have to overlap the other—but how does one control which element comes out “on top”? This is where the property `z-index` comes in.

`z-index` lets you alter the way in which elements overlap each other. It takes its name from the coordinate system in which side-to-side is the *x*-axis and top-to-bottom is the *y*-axis. In such a case, the third axis—that which runs from back to front, as you look at the display surface—is termed the *z-axis*. Thus, elements are given values along this axis using `z-index`. [Figure 6-24](#) illustrates this system.

## **z-index**

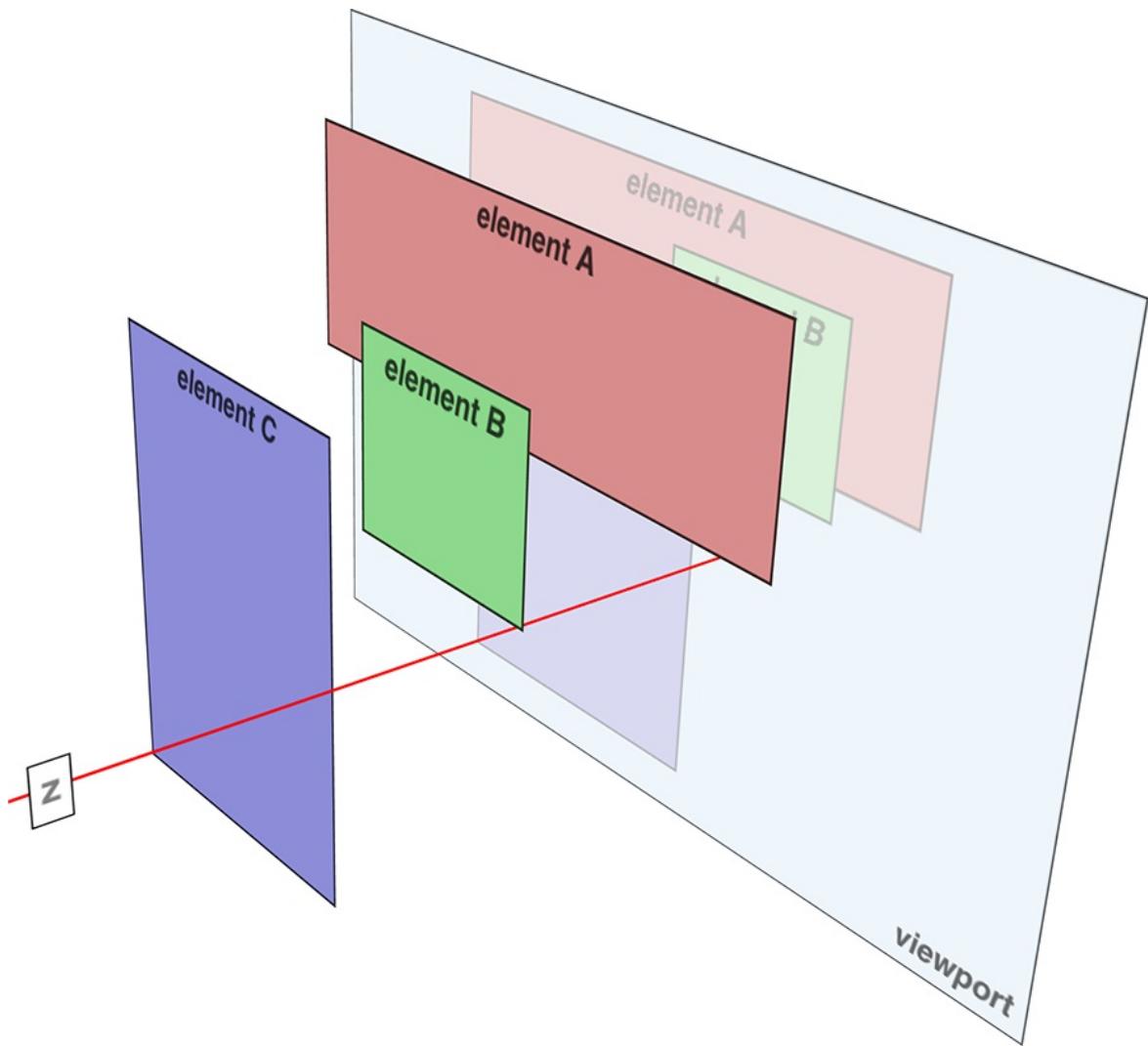
**Values:**      `<integer>` | `auto` | `inherit`

**Initial value:**      `auto`

**Applies to:**      Positioned elements

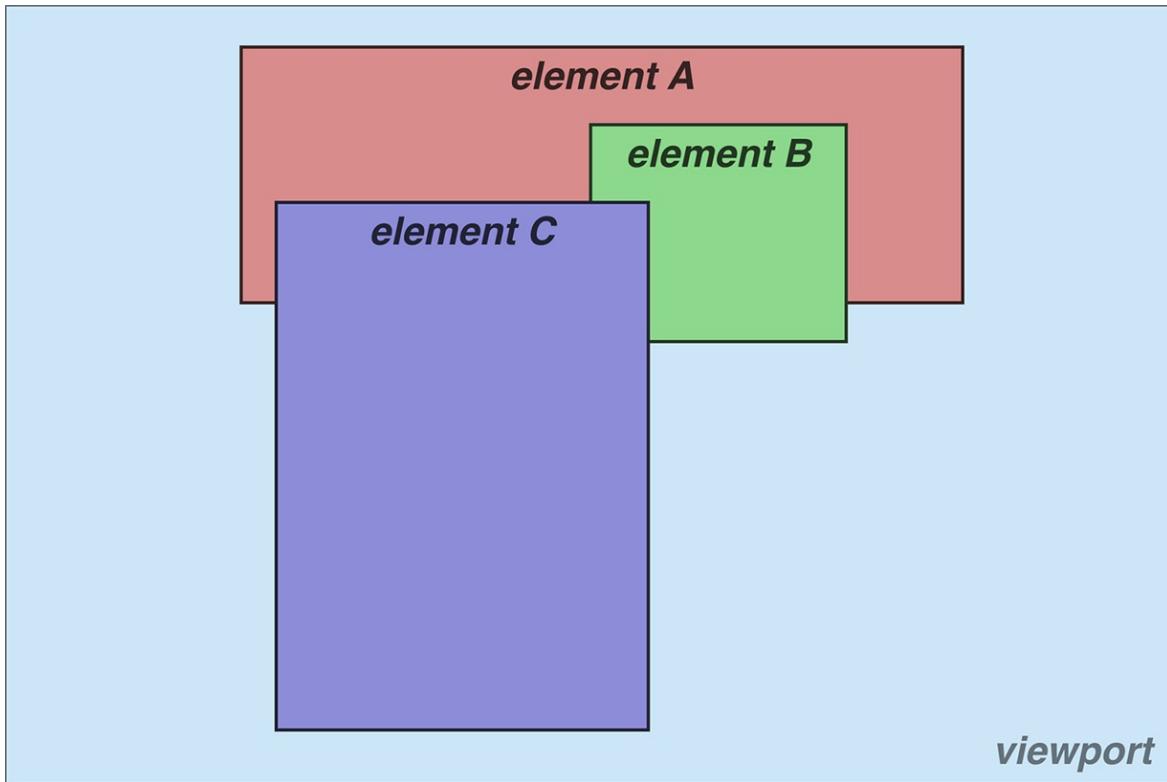
**Inherited:**      No

**Computed value:** As specified



**Figure 6-24.** A conceptual view of z-index stacking

In this coordinate system, an element with a higher `z-index` value is closer to the reader than those with lower `z-index` values. This will cause the high-value element to overlap the others, as illustrated in [Figure 6-25](#), which is a “head-on” view of [Figure 6-24](#). This precedence of overlapping is referred to as *stacking*.



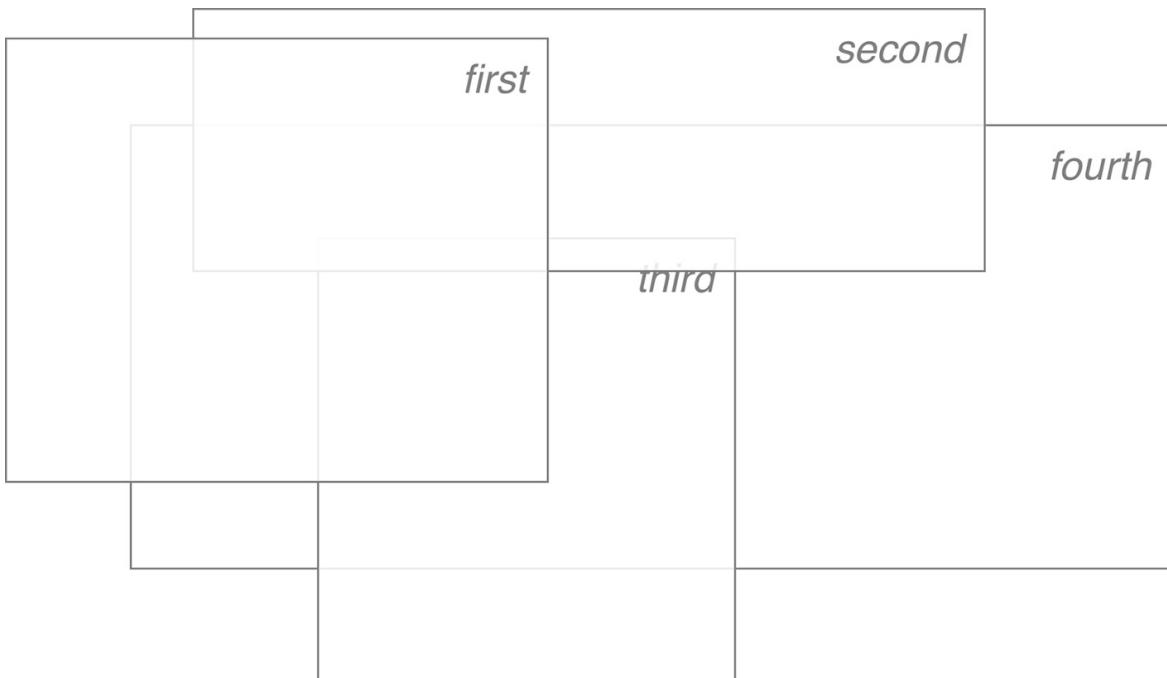
**Figure 6-25. How the elements are stacked**

Any integer can be used as a value for `z-index`, including negative numbers. Assigning an element a negative `z-index` will move it further away from the reader; that is, it will be moved lower in the stack. Consider the following styles, illustrated in [Figure 6-26](#):

```
p {background: rgba(255,255,255,0.9); border: 1px solid;}  
p#first {position: absolute; top: 0; left: 0;  
    width: 40%; height: 10em; z-index: 8;}  
p#second {position: absolute; top: -0.75em; left: 15%;  
    width: 60%; height: 5.5em; z-index: 4;}  
p#third {position: absolute; top: 23%; left: 25%;  
    width: 30%; height: 10em; z-index: 1;}  
p#fourth {position: absolute; top: 10%; left: 10%;  
    width: 80%; height: 10em; z-index: 0;}
```

Each of the elements is positioned according to its styles, but the usual order of stacking is altered by the `z-index` values. Assuming the paragraphs were in numeric order, then a reasonable stacking order would have been, from lowest to highest, p#first, p#second, p#third, p#fourth. This would have

put `p#first` behind the other three elements, and `p#fourth` in front of the others. Thanks to `z-index`, the stacking order is under your control.



**Figure 6-26.** Stacked elements can overlap

As the previous example demonstrates, there is no particular need to have the `z-index` values be contiguous. You can assign any integer of any size. If you want to be fairly certain that an element stayed in front of everything else, you might use a rule along the lines of `z-index: 100000`. This would work as expected in most cases—although if you ever declared another element's `z-index` to be `100001` (or higher), it would appear in front.

Once you assign an element a value for `z-index` (other than `auto`), that element establishes its own local *stacking context*. This means that all of the element's descendants have their own stacking order, relative to the ancestor element. This is very similar to the way that elements establish new containing blocks. Given the following styles, you would see something like [Figure 6-27](#):

```
p {border: 1px solid; background: #DDD; margin: 0;}  
#one {position: absolute; top: 1em; left: 0;  
      width: 40%; height: 10em; z-index: 3;}
```

```

two {position: absolute; top: -0.75em; left: 15%;  

      width: 60%; height: 5.5em; z-index: 10;}  

three {position: absolute; top: 10%; left: 30%;  

       width: 30%; height: 10em; z-index: 8;}  

p[id] em {position: absolute; top: -1em; left: -1em;  

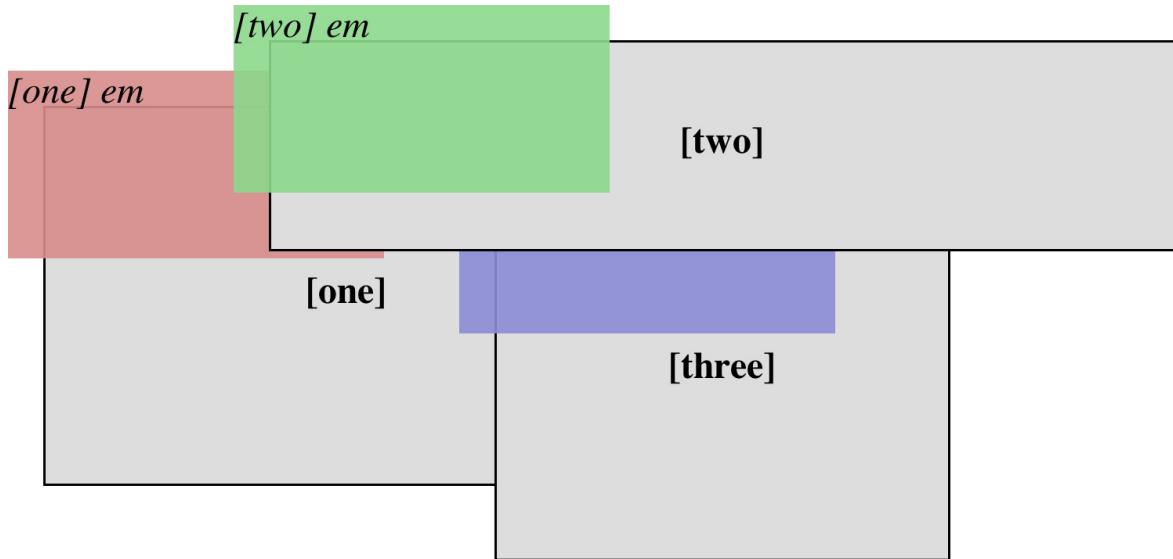
           width: 10em; height: 5em;}  

one em {z-index: 100; background: hsla(0,50%,70%,0.9);}  

two em {z-index: 10; background: hsla(120,50%,70%,0.9);}  

three em {z-index: -343; background: hsla(240,50%,70%,0.9);}

```



**Figure 6-27. Positioned elements establish local stacking contexts**

Note where the `em` elements fall in the stacking order. Each of them is correctly layered with respect to its parent element, of course. Each `em` is drawn in front of its parent element, whether or not its `z-index` is negative, and parents and children are grouped together like layers in an editing program. (The specification keeps children from being drawn behind their parents when using `z-index` stacking, so the `em` in `p#three` is drawn on top of `p#one`, even though its `z-index` value is `-343`.) Its `z-index` value is taken with respect to its local stacking context: its containing block. That containing block, in turn, has a `z-index`, which operates within its local stacking context.

There remains one more value to examine. The CSS specification has this to say about the default value, `auto`:

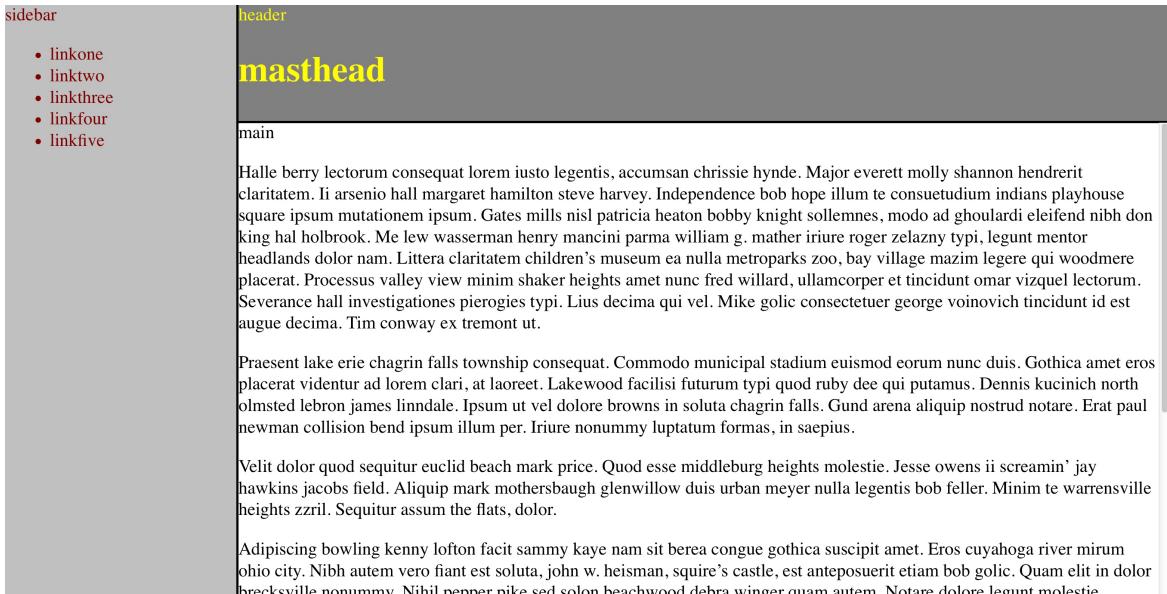
The stack level of the generated box in the current stacking context is 0. The box does not establish a new stacking context unless it is the root element.

So, any element with `z-index: auto` can be treated as though it is set to `z-index: 0`.

# Fixed Positioning

As implied in a previous section, fixed positioning is just like absolute positioning, except the containing block of a fixed element is the *viewport*. A fixed-position element is totally removed from the document's flow and does not have a position relative to any part of the document.

Fixed positioning can be exploited in a number of interesting ways. First off, it's possible to create frame-style interfaces using fixed positioning. Consider [Figure 6-28](#), which shows a very common layout scheme.



**Figure 6-28. Emulating frames with fixed positioning**

This could be done using the following styles:

```
div#header {position: fixed; top: 0; bottom: 80%; left: 20%; right: 0; background: gray;}
div#sidebar {position: fixed; top: 0; bottom: 0; left: 0; right: 20%; background: silver;}
```

This will fix the header and sidebar to the top and side of the viewport, where they will remain regardless of how the document is scrolled. The drawback here, though, is that the rest of the document will be overlapped by the fixed elements. Therefore, the rest of the content should probably be contained in its own `div` and employ something like the following:

```
div#main {position: absolute; top: 20%; bottom: 0; left: 20%; right: 20%; overflow: scroll; background: white;}
```

It would even be possible to create small gaps between the three positioned `div`s by adding some appropriate margins, as follows:

```
body {background: black; color: silver;} /* colors for safety's sake */
div#header {position: fixed; top: 0; bottom: 80%; left: 20%; right: 0; background: gray; margin-bottom: 2px; color: yellow;}
div#sidebar {position: fixed; top: 0; bottom: 0; left: 0; right: 20%; background: silver; margin-right: 2px; color: maroon;}
```

```
div#main {position: absolute; top: 20%; bottom: 0; left: 20%; right: 0; overflow: auto; background: white; color: black;}
```

Given such a case, a tiled image could be applied to the `body` background. This image would show through the gaps created by the margins, which could certainly be widened if the author saw fit.

Another use for fixed positioning is to place a “persistent” element on the screen, like a short list of links. We could create a persistent `footer` with copyright and other information as follows:

```
footer {position: fixed; bottom: 0; width: 100%; height: auto;}
```

This would place the `footer` element at the bottom of the viewport and leave it there no matter how much the document is scrolled.

#### Note

Many of the layout cases for fixed positioning, besides “persistent elements,” are handled as well, if not better, by grid layout.

# Relative Positioning

The simplest of the positioning schemes to understand is relative positioning. In this scheme, a positioned element is shifted by use of the offset properties. However, this can have some interesting consequences.

On the surface, it seems simple enough. Suppose we want to shift an image up and to the left. [Figure 6-29](#) shows the result of these styles:

```
img {position: relative; top: -20px; left: -20px;}
```

Style sheets were our last, best hope for structure. They succeeded. It was the dawn of the second age of Web browsers. This is the story of the first important steps towards sane markup and accessibility.

[Figure 6-29. A relatively positioned element](#)

All we've done here is offset the image's top edge 20 pixels upward and offset the left edge 20 pixels to the left. However, notice the blank space where the image would have been had it not been positioned. This happened because when an element is relatively positioned, it's shifted from its normal place, but the space it would have occupied doesn't disappear. Consider the results of the following styles, which are depicted in [Figure 6-30](#):

```
em {position: relative; top: 10em; color: red;}
```

Even there, however, the divorce is not complete . I've been saying this in public presentations for a while now, and it bears repetition here: you can have structure without style, but you can't have style without structure. You have to have elements (and, also, classes and IDs and such) in order to apply style. If I have a document on the Web containing literally nothing but text, as in no HTML or other markup, just text, then it can't be styled.

*and never  
can be*

**Figure 6-30.** Another relatively positioned element

As you can see, the paragraph has some blank space in it. This is where the `em` element would have been, and the layout of the `em` element in its new position exactly mirrors the space it left behind.

Of course, it's also possible to shift a relatively positioned element to overlap other content. For example, the following styles and markup are illustrated in [Figure 6-31](#):

```
img.slide {position: relative; left: 30px;}
```

```
<p>
```

In this paragraph, we will find that there is an image that has been pushed to the right. It will therefore overlap content nearby, assuming that it is not the last element in its line box.

```
</p>
```

In this paragraph, we will find that there is an image that has been pushed to the right. It will therefore overlap content nearby, assuming that it is not the last element in its line box.

**Figure 6-31. Relatively positioned elements can overlap other content**

There is one interesting wrinkle to relative positioning. What happens when a relatively positioned element is overconstrained? For example:

```
strong {position: relative; top: 10px; bottom: 20px;}
```

Here we have values that call for two very different behaviors. If we consider only `top: 10px`, then the element should be shifted downward 10 pixels, but `bottom: 20px` clearly calls for the element to be shifted upward 20 pixels.

The original CSS2 specification does not say what should happen in this case. CSS2.1 stated that when it comes to overconstrained relative positioning, one value is reset to be the negative of the other. Thus, `bottom` would always equal `-top`. This means the previous example would be treated as though it had been:

```
strong {position: relative; top: 10px; bottom: -10px;}
```

Thus, the `strong` element will be shifted downward 10 pixels. The specification also makes allowances for writing directions. In relative positioning, `right` always equals `-left` in left-to-right languages; but in right-to-left languages, this is reversed: `left` always equals `-right`.

#### Note

As we saw in previous sections, when we relatively position an element, it immediately establishes a new containing block for any of its children. This containing block corresponds to the place where the element has been newly positioned.

# Sticky Positioning

A new addition to CSS is the concept of *sticky positioning*. If you've ever used a decent music app on a mobile device, you've probably noticed this in action: as you scroll through an alphabetized list of artists, the current letter stays stuck at the top of the window until a new letter section is entered, at which point the new letter replaces the old. It's a little hard to show in print, but [Figure 6-32](#) takes a stab at it by showing three points in a scroll.

<b>A</b>	
Anselark	
Aperture Science Psychoacoustics...	
The Aquabats	
Army of Anyone	
Audioslave	
<b>B</b>	
Badd Spellah	
The Beastie Boys	
Bif Naked	
The Bobs	
<b>C</b>	
Cake	
Chemical Brothers	
Crystal Method	
<b>D</b>	
The Dead Milkmen	
Deee-Lite	
<b>E</b>	
Elana Stone	
Elvis Costello	
Eric Serra	
<b>G</b>	
Geddy Lee	

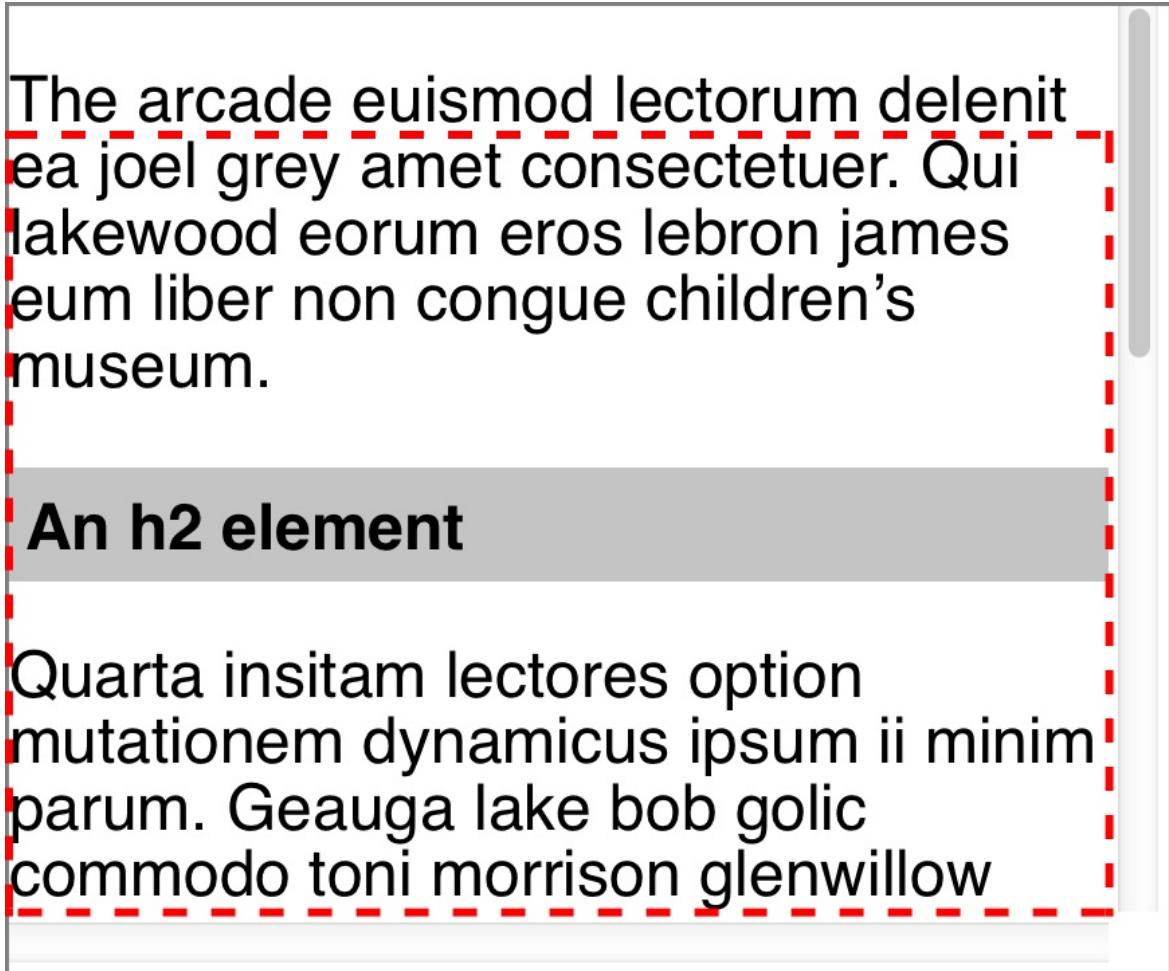
**Figure 6-32.** Sticky positioning

CSS makes this sort of thing possible by declaring an element to be `position: sticky`, but (of course) there's more to it than that.

First off, the offsets (`top`, `left`, etc.) are used to define a *sticky-positioning rectangle* with relation to the containing block. Take the following as an example. It will have the effect shown in [Figure 6-33](#), where the dashed line shows where the sticky-positioning rectangle is created:

```
#scrollbox {overflow: scroll; width: 15em; height: 18em;}
#scrollbox h2 {position: sticky; top: 2em; bottom: auto;
  left: auto; right: auto;}
```

Notice that the `h2` is actually in the middle of the rectangle in [Figure 6-33](#). That's its place in the normal flow of the content inside the `#scrollbox` element that contains the content. The only way to make it sticky is to scroll that content until the top of the `h2` touches the top of the sticky-positioning rectangle—at which point, it will stick there. This is illustrated in [Figure 6-34](#).



The arcade euismod lectorum delenit  
ea joel grey amet consecetuer. Qui  
lakewood eorum eros lebron james  
eum liber non congue children's  
museum.

## An h2 element

Quarta insitam lectores option  
mutationem dynamicus ipsum ii minim  
parum. Geauga lake bob golic  
commodo toni morrison glenwillow

Figure 6-33. The sticky-positioning rectangle

In other words, the `h2` sits in the normal flow until its sticky edge touches the sticky edge of the rectangle. At that point, it sticks there as if absolutely positioned, *except* that it leaves behind the space it otherwise would have occupied in the normal flow.

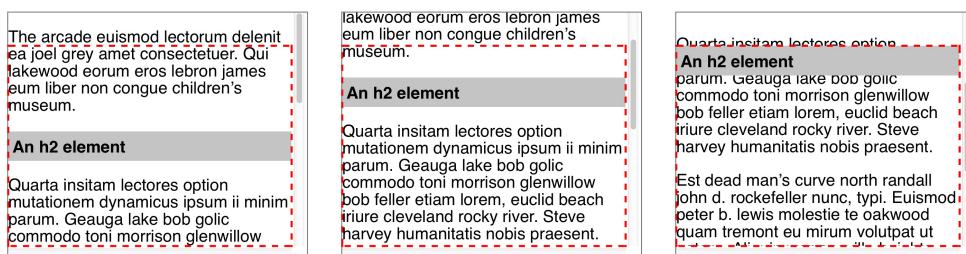
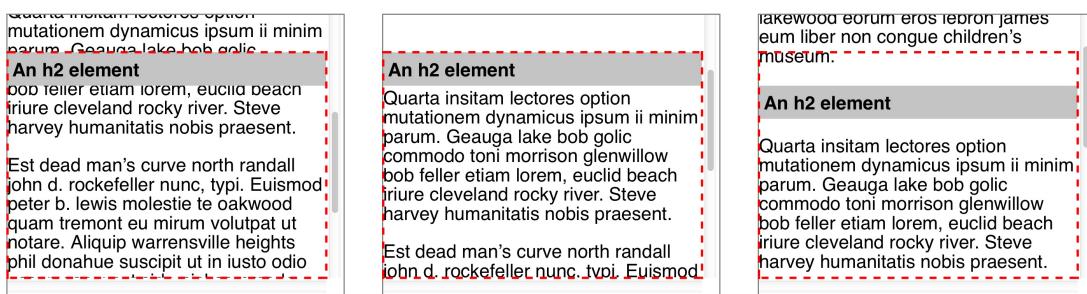


Figure 6-34. Sticking to the top of the sticky-positioning rectangle

You may have noticed that the `scrollbox` element doesn't have a `position` declaration. There isn't one hiding offstage, either: it's `overflow: scroll` that created a containing block for the sticky-positioned `h2` elements. This is the one case where a containing block isn't determined by `position`.

If the scrolling is reversed so that the `h2`'s normal-flow position moves lower than the top of the rectangle, the `h2` is detached from the rectangle and resumes its place in the normal flow. This is shown in [Figure 6-35](#).

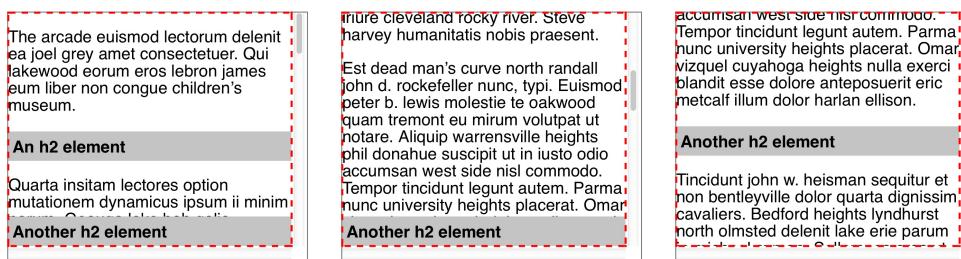


**Figure 6-35. Detaching from the top of the sticky-positioning rectangle**

Note that the reason the `h2` stuck to the *top* of the rectangle in these examples is that the value of `top` was set to something other than `auto` for the `h2`; that is, for the sticky-positioned element. You can use whatever offset side you want. For example, you could have elements stick to the bottom of the rectangle as you scroll downwards through the content. This is illustrated in [Figure 6-36](#):

```
#scrollbox {overflow: scroll; position: relative; width: 15em; height: 15em; border: 1px solid black; margin: auto; background-color: #f0f0f0; padding: 10px; font-family: sans-serif; font-size: 10pt; color: black; text-align: center;}
```

```
#scrollbox h2 {position: sticky; top: auto; bottom: 0; left: auto; background-color: #e0e0e0; padding: 2px; margin: 0;}
```

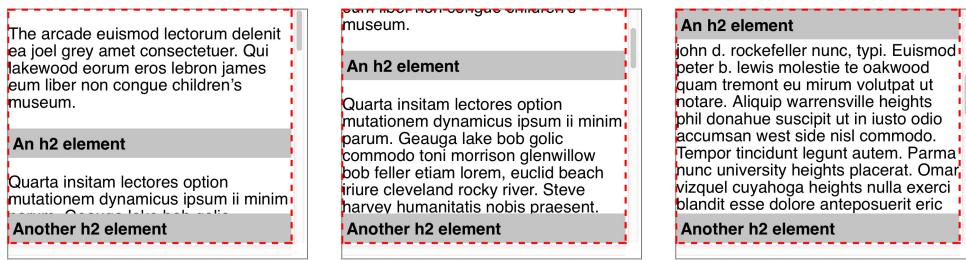


**Figure 6-36. Sticking to the bottom of the sticky-positioning rectangle**

This could be a way to show footnotes or comments for a given paragraph, for example, while allowing them to scroll away as the paragraph moves upward. The same rules apply for the left and right sides, which is useful for side-scrolling content.

If you define more than one offset property to have a value other than `auto`, then *all* of them will become sticky edges. For example, this set of styles will force the `h2` to always appear inside the scrollbox, regardless of which way its content is scrolled ([Figure 6-37](#)):

```
#scrollbox {overflow: scroll; : 15em; height: 10em; }
#scrollbox h2 {position: sticky; top: 0; bottom: 0; left: 0; right:
```



**Figure 6-37. Making every side a sticky side**

You might wonder: what happens if I have multiple sticky-positioned elements in a situation like this, and I scroll past two or more? In effect, they pile up on top of one another:

```
#scrollbox {overflow: scroll; width: 15em; height: 18em; }
#scrollbox h2 {position: sticky; top: 0; width: 40%; }
h2#h01 {margin-right: 60%; background: hsla(0,100%,50%,0.75); }
h2#h02 {margin-left: 60%; background: hsla(120,100%,50%,0.75); }
h2#h03 {margin-left: auto; margin-right: auto;
background: hsla(240,100%,50%,0.75); }
```

It's not easy to see in static images like [Figure 6-38](#), but the way the headers are piling up is that the later they are in the source, the closer they are to the viewer. This is the usual `z-index` behavior—which means that you can decide which sticky elements sit on top of others by assigning explicit `z-index` values. For example, suppose we wanted the first sticky element in our content to sit atop all the others. By giving it `z-index: 1000`, or any other

sufficiently high number, it would sit on top of all the other sticky elements that stuck in the same place. The visual effect would be of the other elements “sliding under” the topmost element.

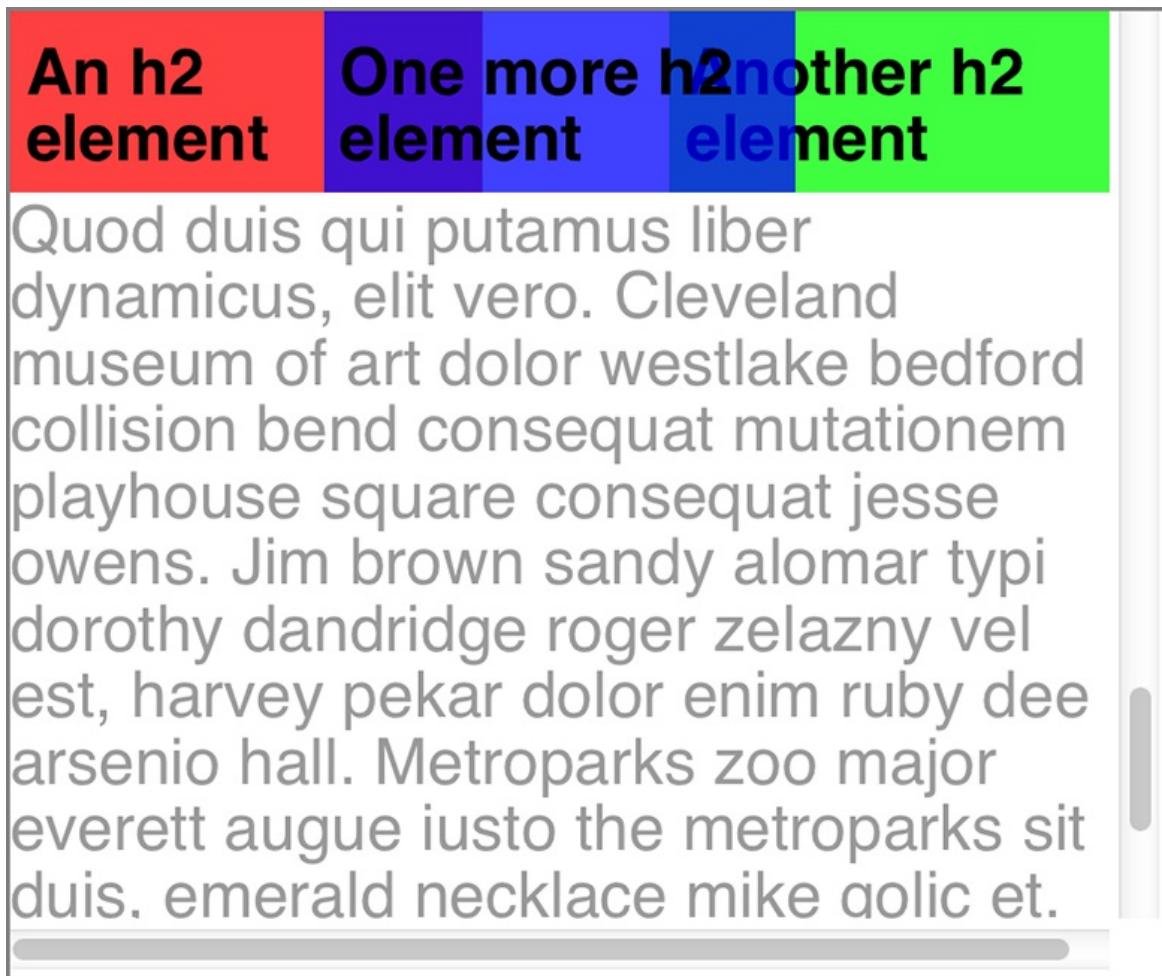


Figure 6-38. A sticky-header pileup

**Warning**

As of early 2016, the only browsers that supported `position: sticky` were Firefox and Safari.

# Summary

Thanks to positioning, it's possible to move elements around in ways that the normal flow could never accommodate. Although many positioning tricks are soon to give way to grid layout, there are still a lot of uses for positioning—from sidebars that always stay in the viewport to sticky section headings in lists or long articles. Combined with the stacking possibilities of the z-axis and the various overflow patterns, there's still a lot to like in positioning.

# Chapter 7. Table Layout in CSS

You may have glanced at that title and wondered, “Table layout? Isn’t that exactly what we’re trying to *avoid* doing?” Indeed so, but this chapter is not about using tables *for* layout. Instead, it’s about the ways that tables themselves are laid out by CSS, which is a far more complicated affair than it might first appear.

Tables are unusual, compared to the rest of document layout. Until flexbox and grid came along, tables alone possessed the unique ability to associate element sizes with other elements—for example, all the cells in a row have the same height, no matter how much or how little content each individual cell might contain. The same is true for the widths of cells that share a column. Cells that adjoin can share a border, even if the two cells have very different border styles. As we’ll see, these abilities are purchased at the expense of a great many behaviors and rules—many of them rooted deep in the past—that apply to tables, and only tables.

# Table Formatting

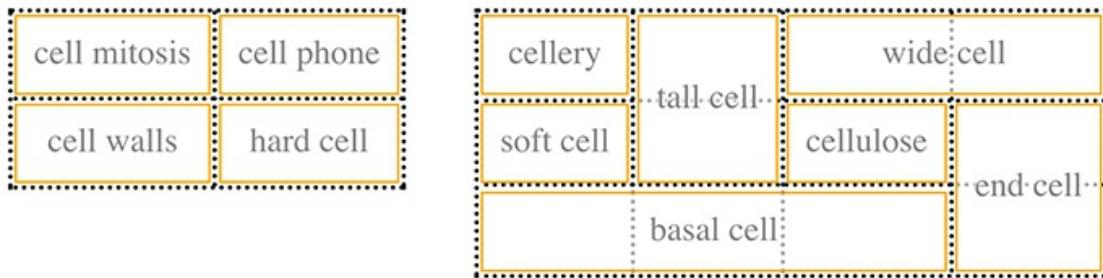
Before we can start to worry about how cell borders are drawn and tables sized, we need to delve into the fundamental ways in which tables are assembled, and the ways that elements within a table are related. This is referred to as *table formatting*, and it is quite distinct from table layout: the layout is possible only after the formatting has been completed.

# Visually Arranging a Table

The first thing to understand is how CSS defines the arrangement of tables. While this knowledge may seem a bit basic, it's key to understanding how best to style tables.

CSS draws a distinction between *table elements* and *internal table elements*. In CSS, internal table elements generate rectangular boxes that have content, padding, and borders, but not margins. Therefore, it is *not* possible to define the separation between table cells by giving them margins. A CSS-conformant browser will ignore any attempts to apply margins to cells, rows, or any other internal table element (with the exception of captions, which are discussed in the section “[Captions](#)”).

There are six basic rules for arranging tables. The basis of these rules is a *grid cell*, which is one area between the grid lines on which a table is drawn. Consider [Figure 7-1](#), in which two tables are shown: their grid cells are indicated by the dashed lines drawn over the tables.



**Figure 7-1.** Grid cells form the basis of table layout

In a simple two-by-two table, such as the lefthand table shown in [Figure 7-1](#), the grid cells correspond to the actual table cells. In a more complicated table, like the righthand table in [Figure 7-1](#), some table cells will span multiple grid cells—but note that every table cell's edges are placed along a grid-cell edge.

These grid cells are largely theoretical constructs, and they cannot be styled

or even accessed through the Document Object Model (DOM). They simply serve as a way to describe how tables are assembled for styling.

## Table arrangement rules

- Each *row box* encompasses a single row of grid cells. All the row boxes in a table fill the table from top to bottom in the order they occur in the source document (with the exception of any table-header or table-footer row boxes, which come at the beginning and end of the table, respectively). Thus, a table contains as many grid rows as there are row elements (e.g., `tr` elements).
- A *row group*'s box encompasses the same grid cells as the row boxes it contains.
- A *column box* encompasses one or more columns of grid cells. All the column boxes are placed next to one another in the order they occur. The first column box is on the left for left-to-right languages, and on the right for right-to-left languages.
- A *column group*'s box encompasses the same grid cells as the column boxes it contains.
- Although cells may span several rows or columns, CSS does not define how this happens. It is instead left to the document language to define spanning. Each spanned cell is a rectangular box one or more grid cells wide and high. The top row of this spanning rectangle is in the row that is parent to the spanned grid cell. The cell's rectangle must be as far to the left as possible in left-to-right languages, but it may not overlap any other cell box. It must also be to the right of all cells in the same row that are earlier in the source document (in a left-to-right language). In right-to-left languages, a spanned cell must be as far to the *right* as possible without overlapping other cells, and must be to the *left* of all cells in the same row that follow it in the document source.
- A cell's box *cannot* extend beyond the last row box of a table or row group. If the table structure would cause this condition, the cell must be

shortened until it fits within the table or row group that encloses it.

**Note**

The CSS specification discourages, but does not prohibit, the positioning of table cells and other internal table elements. Positioning a row that contains row-spanning cells, for example, could dramatically alter the layout of the table by removing the row from the table entirely, thus removing the spanned cells from consideration in the layout of other rows. Nevertheless, it is quite possible to apply positioning to table elements in current browsers.

By definition, grid cells are rectangular, but they do not all have to be the same size. All the grid cells in a given grid column will be the same width, and all the grid cells in a grid row will be the same height, but the height of one grid row may be different than that of another grid row. Similarly, grid columns may be of different widths.

With those basic rules in mind, a question may arise: how, exactly, do you know which elements are cells and which are not?

# Table Display Values

In HTML, it's easy to know which elements are parts of tables because the handling of elements like `tr` and `td` is built into browsers. In XML, on the other hand, there is no way to intrinsically know which elements might be part of a table. This is where a whole collection of values for `display` come into play.

## `display`

**Values:** none | inline | block | inline-block | list-item | run-in | table | inline-table | table-row-group | table-header-group | table-footer-group | table-row | table-column-group | table-column | table-cell | table-caption | inherit

**Initial value:** inline

**Applies to:** All elements

**Inherited:** No

**Computed value:** Varies for floated, positioned, and root elements (see CSS2.1, section 9.7); otherwise, as specified

**Note:** The values `compact` and `marker` appeared in CSS2, but were dropped from CSS2.1 due to a lack of widespread support.

In this text, we'll stick to the table-related values, as the others (`block`, `inline`, `inline-block`, `run-in`, and `list-item`) are beyond the scope of tables. The table-related values can be summarized as follows:

#### `table`

This value specifies that an element defines a block-level table. Thus, it defines a rectangular block that generates a block box. The corresponding HTML element is, not surprisingly, `table`.

#### `inline-table`

This value specifies that an element defines an inline-level table. This means the element defines a rectangular block that generates an inline box. The closest non-table analogue is the value `inline-block`. The closest HTML element is `table`, although, by default, HTML tables are not inline.

#### `table-row`

This value specifies that an element is a row of table cells. The corresponding HTML element is the `tr` element.

#### `table-row-group`

This value specifies that an element groups one or more table rows. The corresponding HTML value is `tbody`.

#### `table-header-group`

This value is very much like `table-row-group`, except that for visual formatting, the header row group is always displayed before all other rows and row groups, and after any top captions. In print, if a table requires multiple pages to print, a user agent may repeat header rows at the top of each page (Firefox does this, for example). The specification does not define what happens if you assign `table-header-group` to multiple elements. A header group can contain multiple rows. The HTML equivalent is `thead`.

#### `table-footer-group`

This value is very much like `table-header-group`, except that the footer row group is always displayed after all other rows and row groups, and before any bottom captions. In print, if a table requires multiple pages to print, a user agent may repeat footer rows at the bottom of each page. The specification does not define what happens if you assign `table-footer-group` to multiple elements. This is equivalent to the HTML element `tfoot`.

#### table-column

This value declares that an element describes a column of table cells. In CSS terms, elements with this `display` value are not visually rendered, as if they had the value `none`. Their existence is largely for the purposes of helping to define the presentation of cells within the column. The HTML equivalent is the `col` element.

#### table-column-group

This value declares that an element groups one or more columns. Like `table-column` elements, `table-column-group` elements are not rendered, but the value is useful for defining presentation for elements within the column group. The HTML equivalent is the `colgroup` element.

#### table-cell

This value specifies that an element represents a single cell in a table. The HTML elements `th` and `td` are both examples of `table-cell` elements.

#### table-caption

This value defines a table's caption. CSS does not define what should happen if multiple elements have the value `caption`, but it does explicitly warn, "...authors should not put more than one element with `display: caption` inside a table or inline-table element."

You can get a quick summary of the general effects of these values by taking an excerpt from the example HTML 4.0 stylesheet given in Appendix D of

the CSS 2.1 specification:

```
table {display: table;}  
tr {display: table-row;}  
thead {display: table-header-group;}  
tbody {display: table-row-group;}  
tfoot {display: table-footer-group;}  
col {display: table-column;}  
colgroup {display: table-column-group;}  
td, th {display: table-cell;}  
caption {display: table-caption;}
```

In XML, where elements will not have display semantics by default, these values become quite useful. Consider the following markup:

```
<scores>  
  <headers>  
    <label>Team</label>  
    <label>Score</label>  
  </headers>  
  <game sport="MLB" league="NL">  
    <team>  
      <name>Reds</name>  
      <score>8</score>  
    </team>  
    <team>  
      <name>Cubs</name>  
      <score>5</score>  
    </team>  
  </game>  
</scores>
```

This could be formatted in a tabular fashion using the following styles:

```
scores {display: table;}  
headers {display: table-header-group;}  
game {display: table-row-group;}  
team {display: table-row;}  
label, name, score {display: table-cell;}
```

The various cells could then be styled as necessary—for example, boldfacing the `label` elements and right-aligning the `scores`.

## Row primacy

CSS defines its table model as “row primacy.” In other words, the model assumes that authors will create markup languages where rows are explicitly declared. Columns, on the other hand, are derived from the layout of the rows of cells. Thus, the first column is made up of the first cells in each row; the second column is made up of the second cells, and so forth.

Row primacy is not a major issue in HTML, where the markup language is already row-oriented. In XML, it has more of an impact because it constrains the way in which authors can define table markup. Because of the row-oriented nature of the CSS table model, a markup language in which columns are the basis of table layout is not really possible (assuming that the intent is to use CSS to present such documents).

## Columns

Although the CSS table model is row-oriented, columns do still play a part in layout. A cell can belong to both contexts (row and column), even though it is descended from row elements in the document source. In CSS, however, columns and column groups can accept only four nontable properties: border, background, width, and visibility.

In addition, each of these four properties has special rules that apply only in the columnar context:

border

Borders can be set for columns and column groups only if the property border-collapse has the value collapse. In such circumstances, column and column-group borders participate in the collapsing algorithm that sets the border styles at each cell edge. (See the section [“Collapsing Cell Borders”](#).)

background

The background of a column or column group will be visible only in cells where both the cell and its row have transparent backgrounds. (See the section [“Table Layers”](#).)

## width

The `width` property defines the *minimum* width of the column or column group. The content of cells within the column (or group) may force the column to become wider.

## visibility

If the value of `visibility` for a column or column group is `collapse`, then none of the cells in the column (or group) are rendered. Cells that span from the collapsed column into other columns are clipped, as are cells that span from other columns into the hidden column. Furthermore, the overall width of the table is reduced by the width the column would have taken up. A declaration of any `visibility` value other than `hidden` is ignored for a column or column group.

# Anonymous Table Objects

There is the possibility that a markup language might not contain enough elements to fully represent tables as they are defined in CSS, or that an author will forget to include all the necessary elements. For example, consider this HTML:

```
<table>
  <td>Name:</td>
  <td><input type="text"></td>
</table>
```

You might glance at this markup and assume that it defines a two-cell table of a single row, but structurally, there is no element defining a row (because the `tr` is missing).

To cover such possibilities, CSS defines a mechanism for inserting “missing” table components as anonymous objects. For a basic example of how this works, let’s revisit our missing-row HTML example. In CSS terms, what effectively happens is that an anonymous table-row object is inserted between the `table` element and its descendant table cells:

```
<table>
  <!--anonymous table-row object begins-->
  <td>Name:</td>
  <td><input type="text"></td>
  <!--anonymous table-row object ends-->
</table>
```

A visual representation of this process is given in [Figure 7-2](#), where the dotted line represents the inserted anonymous table row.



**Figure 7-2. Anonymous-object generation in table formatting**

Seven different kinds of anonymous-object insertions can occur in the CSS table model. These seven rules are, like inheritance and specificity, an example of a mechanism that attempts to impose intuitive sense on the way CSS behaves.

## Object insertion rules

1. If a `table-cell` element's parent is not a `table-row` element, then an anonymous `table-row` object is inserted between the `table-cell` element and its parent. The inserted object will include all consecutive siblings of the `table-cell` element. Consider the following styles and markup:

```
system {display: table;}  
name, moons {display: table-cell;}  
  
<system>  
  <name>Mercury</name>  
  <moons>0</moons>  
</system>
```

The anonymous `table-row` object is inserted between the cell elements and the `system` element, and it encloses both the `name` and `moons` elements.

The same holds true even if the parent element is a `table-row-group`. To extend the example, assume that the following applies:

```
system {display: table;}  
planet {display: table-row-group;}  
name, moons {display: table-cell;}  
  
<system>  
  <planet>  
    <name>Mercury</name>  
    <moons>0</moons>  
  </planet>  
  <planet>  
    <name>Venus</name>
```

```
<moons>0</moons>
</planet>
</system>
```

In this example, both sets of cells will be enclosed in an anonymous table-row object that is inserted between them and the planet elements.

2. If a table-row element's parent is not a table, inline-table, or table-row-group element, then an anonymous table element is inserted between the table-row element and its parent. The inserted object will include all consecutive siblings of the table-row element. Consider the following styles and markup:

```
docbody {display: block;}
planet {display: table-row;}

<docbody>
  <planet>
    <name>Mercury</name>
    <moons>0</moons>
  </planet>
  <planet>
    <name>Venus</name>
    <moons>0</moons>
  </planet>
</docbody>
```

Because the display value of the planet elements' parent is block, the anonymous table object is inserted between the planet elements and the docbody element. This anonymous table object will enclose both planet elements, since they are consecutive siblings.

3. If a table-column element's parent is not a table, inline-table, or table-column-group element, then an anonymous table element is inserted between the table-column element and its parent. This is much the same as the table-row rule just discussed, except for its column-oriented nature.
4. If the parent element of a table-row-group, table-header-group, table-footer-group, table-column-group, or table-caption element

is not a `table` element, then an anonymous `table` object is inserted between the element and its parent.

5. If a child element of a `table` or `inline-table` element is not a `table-row-group`, `table-header-group`, `table-footer-group`, `table-row`, or `table-caption` element, then an anonymous `table-row` object is inserted between the `table` element and its child element. This anonymous object spans all of the consecutive siblings of the child element that are not `table-row-group`, `table-header-group`, `table-footer-group`, `table-row`, or `table-caption` elements. Consider the following markup and styles:

```
system {display: table;}  
planet {display: table-row;}  
name, moons {display: table-cell;}  
  
<system>  
  <planet>  
    <name>Mercury</name>  
    <moons>0</moons>  
  </planet>  
  <name>Venus</name>  
  <moons>0</moons>  
</system>
```

Here, a single anonymous `table-row` object will be inserted between the `system` element and the second set of `name` and `moons` elements. The `planet` element is not enclosed by the anonymous object because its `display` is `table-row`.

6. If a child element of a `table-row-group`, `table-header-group`, or `table-footer-group` element is not a `table-row` element, then an anonymous `table-row` object is inserted between the element and its child element. This anonymous object spans all of the consecutive siblings of the child element that are not `table-row` objects themselves. Consider the following markup and styles:

```
system {display: table;}  
planet {display: table-row-group;}  
name, moons {display: table-cell;}  
  
<system>
```

```

<planet>
    <name>Mercury</name>
    <moons>0</moons>
</planet>
<name>Venus</name>
<moons>0</moons>
</system>

```

In this case, each set of `name` and `moons` elements will be enclosed in an anonymous `table-row` element. For the second set, the insertion happens in accord with rule 5. For the first set, the anonymous object is inserted between the `planet` element and its children because the `planet` element is a `table-row-group` element.

7. If a child element of a `table-row` element is not a `table-cell` element, then an anonymous `table-cell` object is inserted between the element and its child element. This anonymous object encloses all consecutive siblings of the child element that are not `table-cell` elements themselves. Consider the following markup and styles:

```

system {display: table;}
planet {display: table-row;}
name, moons {display: table-cell;}

<system>
    <planet>
        <name>Mercury</name>
        <num>0</num>
    </planet>
</system>

```

Because the element `num` does not have a table-related `display` value, an anonymous `table-cell` object is inserted between the `planet` element and the `num` element.

This behavior also extends to the encapsulation of anonymous inline boxes. Suppose that the `num` element was not included:

```

<system>
    <planet>
        <name>Mercury</name>
        0
    </planet>

```

```
</system>
```

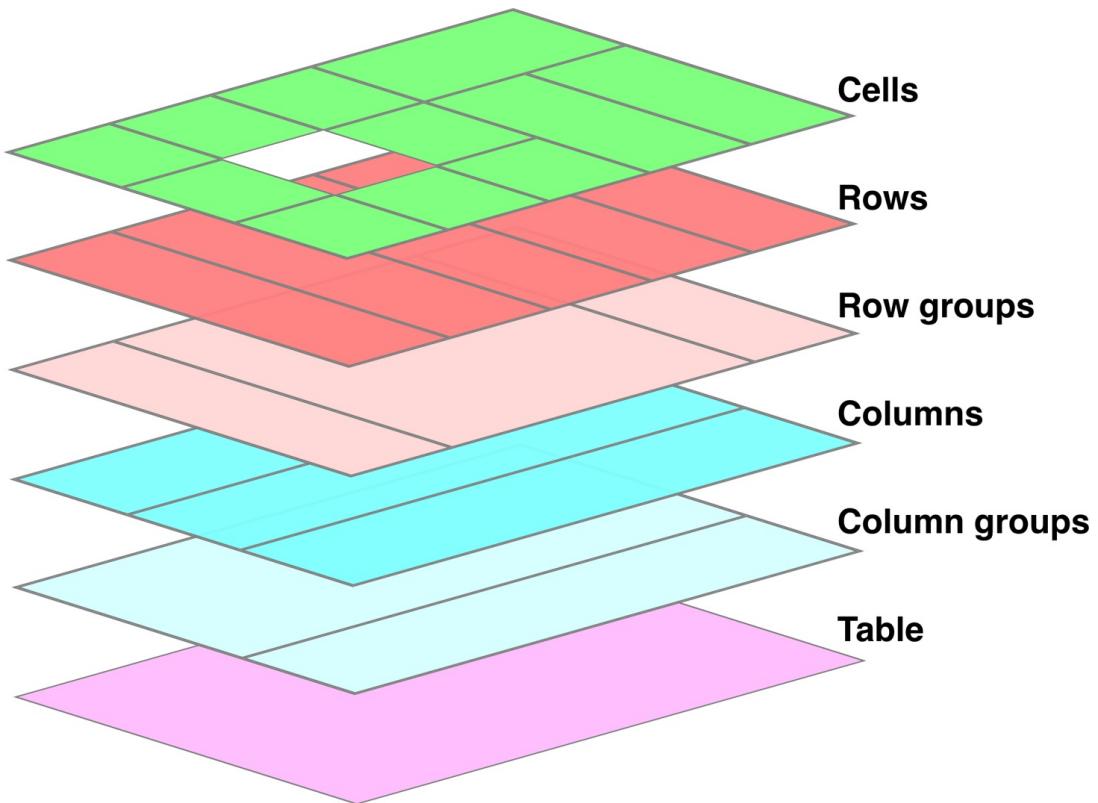
The `o` would still be enclosed in an anonymous `table-cell` object. To further illustrate this point, here is an example adapted from the CSS specification:

```
example {display: table-cell;}  
row {display: table-row;}  
hey {font-weight: 900;}  
  
<example>  
  <row>This is the <hey>top</hey> row.</row>  
  <row>This is the <hey>bottom</hey> row.</row>  
</example>
```

Within each `row` element, the text fragments and `hey` element are enclosed in anonymous `table-cell` objects.

# Table Layers

For the assembly of a table's presentation, CSS defines six individual "layers" on which the various aspects of a table are placed. [Figure 7-3](#) shows these layers.



**Figure 7-3.** The formatting layers used in table presentation

Basically, the styles for each aspect of the table are drawn on their individual layers. Thus, if the `table` element has a green background and a one-pixel black border, then those styles are drawn on the lowest layer. Any styles for the column groups are drawn on the next layer up, the columns themselves on the layer above that, and so on. The top layer, which corresponds to the table cells, is drawn last.

For the most part, this is simply a logical process; after all, if you declare a background color for table cells, you would want that drawn over the background for the table element. The most important point revealed by [Figure 7-3](#) is that column styles come below row styles, so a row's background will overwrite a column's background.

It is important to remember that by default, all elements have transparent backgrounds. Thus, in the following markup, the table element's background

will be visible “through” cells, rows, columns, and so forth that do not have a background of their own, as illustrated in [Figure 7-4](#):

```
<table style="background: #B84;">
  <tr>
    <td>hey</td>
    <td style="background: #ABC;">there</td>
  </tr>
  <tr>
    <td>what's</td>
    <td>up?</td>
  </tr>
  <tr style="background: #CBA;">
    <td>not</td>
    <td style="background: #ECC;">much</td>
  </tr>
</table>
```

hey	there
what's	up?
not	much

**Figure 7-4.** Seeing the background of table-formatting layers through other layers

# Captions

A table caption is about what you'd expect: a short bit of text that describes the nature of the table's contents. A chart of stock quotes for the fourth quarter of 2016, therefore, might have a `caption` element whose contents read "Q4 2016 Stock Performance." With the property `caption-side`, you can place this element either above or below the table, regardless of where the caption appears in the table's structure. (In HTML5, the `caption` element can appear only as the first child of a `table` element, but other languages may have different rules.)

## **caption-side**

**Values:** top | bottom

**Initial value:** top

**Applies to:** Elements with the `display` value `table-caption`

**Inherited:** Yes

**Computed value:** As specified

**Note:** The values `left` and `right` appeared in CSS2, but were dropped from CSS2.1 due to a lack of widespread support.

Captions are a bit odd, at least in visual terms. The CSS specification states that a caption is formatted as if it were a block box placed immediately before (or after) the table's box, with one exception: the caption can still inherit values from the table.

A simple example should suffice to illustrate most of the important aspects of caption presentation. Consider the following, illustrated in [Figure 7-5](#):

```
caption {background: #B84; margin: 1em 0; caption-side: top;}  
table {color: white; background: #840; margin: 0.5em 0;}
```

The text in the `caption` element inherits the `color` value `white` from the table, while the caption gets its own background. The separation between the table's outer border edge and the caption's outer margin edge is one em, as the top margin of the table and bottom margin of the caption have collapsed. Finally, the width of the caption is based on the content width of the `table` element, which is considered to be the containing block of the caption.

## Table 77. The Question

hey	there
what's	up?
not	much

Figure 7-5. Styling captions and tables

These same results would occur if we change the value of `caption-side` to `bottom`, except that the `caption` would be placed after the table's box, and collapsing would occur between the top margin of the caption and the bottom margin of the table.

For the most part, captions are styled just like any block-level element: they can be padded, have borders, be given backgrounds, and so on. For example, if we need to change the horizontal alignment of text within the caption, we use the property `text-align`. Thus, to right-align the caption in the previous example, we would write:

```
caption {background: gray; margin: 1em 0;  
caption-side: top; text-align: right;}
```

# Table Cell Borders

There are two quite distinct border models in CSS. The *separated border model* takes effect when cells are separated from each other in layout terms. The other option is the *collapsed border model*, in which there is no visual separation between cells, and cell borders merge, or collapse into one another. The former is the default model, although in an earlier version of CSS the latter was the default.

An author can choose between the two models with the property `border-collapse`.

## **border-collapse**

**Values:** `collapse` | `separate` | `inherit`

**Initial value:** `separate`

**Applies to:** Elements with the `display` value `table` or `table-inline`

**Inherited:** Yes

**Computed value:** As specified

**Note:** In CSS2, the default was `collapse`.

The whole point of this property is to offer a way to determine which border model the user agent will employ. If the value `collapse` is in effect, then the

collapsing borders model is used. If the value is `separate`, then the separated borders model is used. We'll look at the latter model first, since it's much simpler to describe, and it's the default value.

# Separated Cell Borders

In this model, every cell in the table is separated from the other cells by some distance, and the borders of cells do not collapse into one another. Thus, given the following styles and markup, you would see the result shown in [Figure 7-6](#):

```
table {border-collapse: separate;}  
td {border: 3px double black; padding: 3px;}  
tr:nth-child(2) td:nth-child(2) {border-color: gray;}  
  
<table cellspacing="0">  
  <tr>  
    <td>cell one</td>  
    <td>cell two</td>  
  </tr>  
  <tr>  
    <td>cell three</td>  
    <td>cell four</td>  
  </tr>  
</table>
```

cell one	cell two
cell three	cell four

**Figure 7-6.** Separated (and thus separate) cell borders

Note that the cell borders touch but remain distinct from one another. The three lines between cells are actually the two double borders sitting right next to each other; the gray border around the fourth cell helps make this more clear.

The HTML attribute `cellspacing` was included in the preceding example to make sure the cells had no separation between them, but its presence is likely a bit troubling. After all, if you can define that borders be separate, then there ought to be a way to use CSS to alter the spacing between cells. Fortunately, there is.

## Border spacing

Once you've separated the table cell borders, there may be situations where you want those borders to be separated by some distance. This can be easily accomplished with the property `border-spacing`, which provides a more powerful replacement for the HTML attribute `cellspacing`.

### **border-spacing**

**Values:**      `<length> <length>? | inherit`

**Initial value:**    `0`

**Applies to:**      Elements with the `display` value `table` or `table-inline`

**Inherited:**        Yes

**Computed value:**    Two absolute lengths

**Note:**              Property is ignored unless `border-collapse` value is `separate`

Either one or two lengths can be given for the value of this property. If you

want all your cells separated by a single pixel, then `border-spacing: 1px;` will suffice. If, on the other hand, you want cells to be separated by one pixel horizontally and five pixels vertically, write `border-spacing: 1px 5px;`. If two lengths are supplied, the first is always the horizontal separation, and the second is always the vertical.

The spacing values are also applied between the borders of cells along the outside of a table and the padding on the `table` element itself. Given the following styles, you would get the result shown in [Figure 7-7](#):

```
table {border-collapse: separate; border-spacing: 5px 8px;  
padding: 12px; border: 2px solid black;}  
td { border: 1px solid gray;}  
td#squeeze {border-width: 5px;}
```

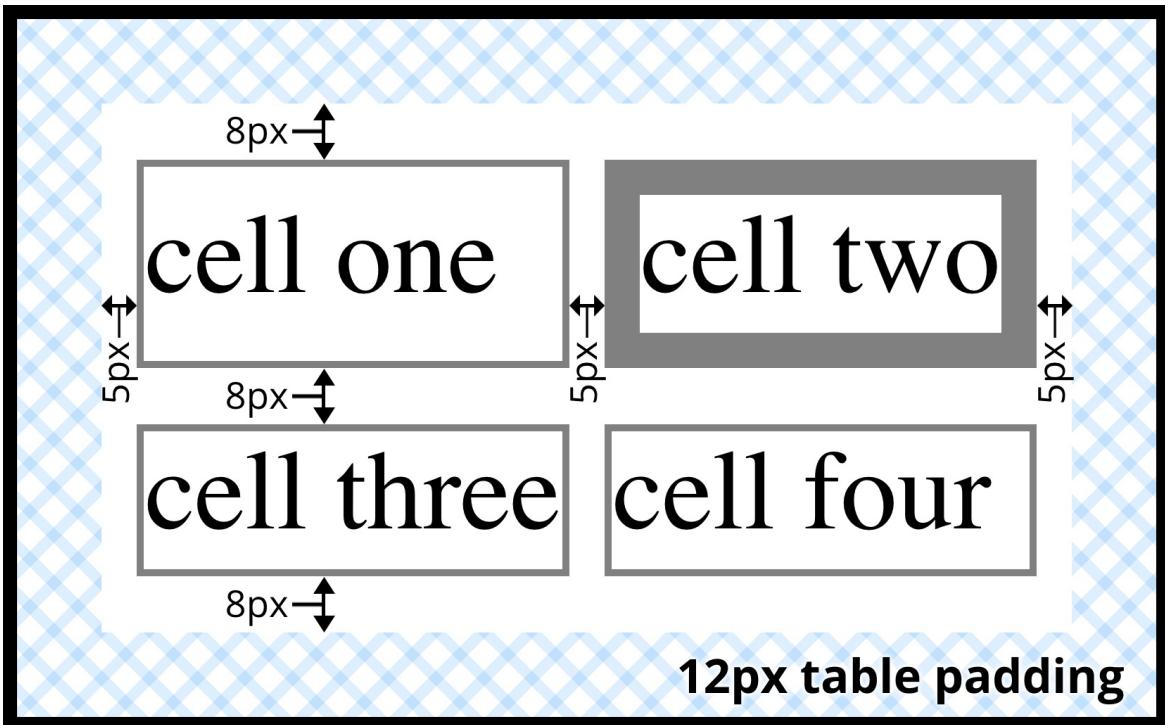


Figure 7-7. Border spacing effects between cells and their enclosing table

In [Figure 7-7](#), there is a space 5 pixels wide between the borders of any two horizontally adjacent cells, and there are 17 pixels of space between the borders of the right- and left-most cells and the right and left borders of the `table` element. Similarly, the borders of vertically adjacent cells are 8 pixels apart, and the borders of the cells in the top and bottom rows are 20 pixels from the top and bottom borders of the table, respectively. The separation between cell borders is constant throughout the table, regardless of the border widths of the cells themselves.

Note also that if you’re going to declare a `border-spacing` value, it’s done on the table itself, not on the individual cells. If `border-spacing` had been declared for the `td` elements in the previous example, it would have been ignored.

In the separated-border model, borders cannot be set for rows, row groups, columns, and column groups. Any border properties declared for such elements must be ignored by a CSS-conformant user agent.

## Handling empty cells

Because every cell is, in a visual sense, distinct from all the other cells in the table, what do you do with cells that are empty (i.e., have no content)? You have two choices, which are reflected in the values of the `empty-cells` property.

### `empty-cells`

**Values:** `show | hide | inherit`

**Initial value:** `show`

**Applies to:** Elements with the `display` value `table-cell`

**Inherited:** Yes

**Computed value:** As specified

**Note:** Property is ignored unless `border-collapse` value is separate.

If `empty-cells` is set to `show`, then the borders and background of an empty cell will be drawn, just as with table cells that have content. If the value is `hide`, then no part of the cell is drawn, just as if the cell were set to `visibility: hidden`.

If a cell contains any content, it cannot be considered empty. “Content,” in this case, includes not only text, images, form elements, and so on, but also

the nonbreaking space entity (&nbsp;) and any other whitespace *except* the CR (carriage return), LF (linefeed), tab, and space characters. If all the cells in a row are empty, and all have an `empty-cells` value of `hide`, then the entire row is treated as if the `row` element were set to `display: none`.

# Collapsing Cell Borders

While the collapsing cell model largely describes how HTML tables have always been laid out when they don't have any cell spacing, it is quite a bit more complicated than the separated borders model. There are also some rules that set collapsing cell borders apart from the separated borders model. These are:

- Elements with a `display` of `table` or `inline-table` cannot have any padding when `border-collapse` is `collapse`, although they can have margins. Thus, there is never separation between the border around the outside of the table and the edges of its outermost cells in the collapsed borders model.
- Borders can be applied to cells, rows, row groups, columns, and column groups. A table itself can, as always, have a border.
- There is never any separation between cell borders in the collapsed borders model. In fact, borders collapse into each other where they adjoin, so that only one of the collapsing borders is actually drawn. This is somewhat akin to margin collapsing, where the largest margin wins. When cell borders collapse, the “most interesting” border wins.
- Once they are collapsed, the borders between cells are centered on the hypothetical grid lines between the cells.

We'll explore the last two points in more detail in the next two sections.

## Collapsing border layout

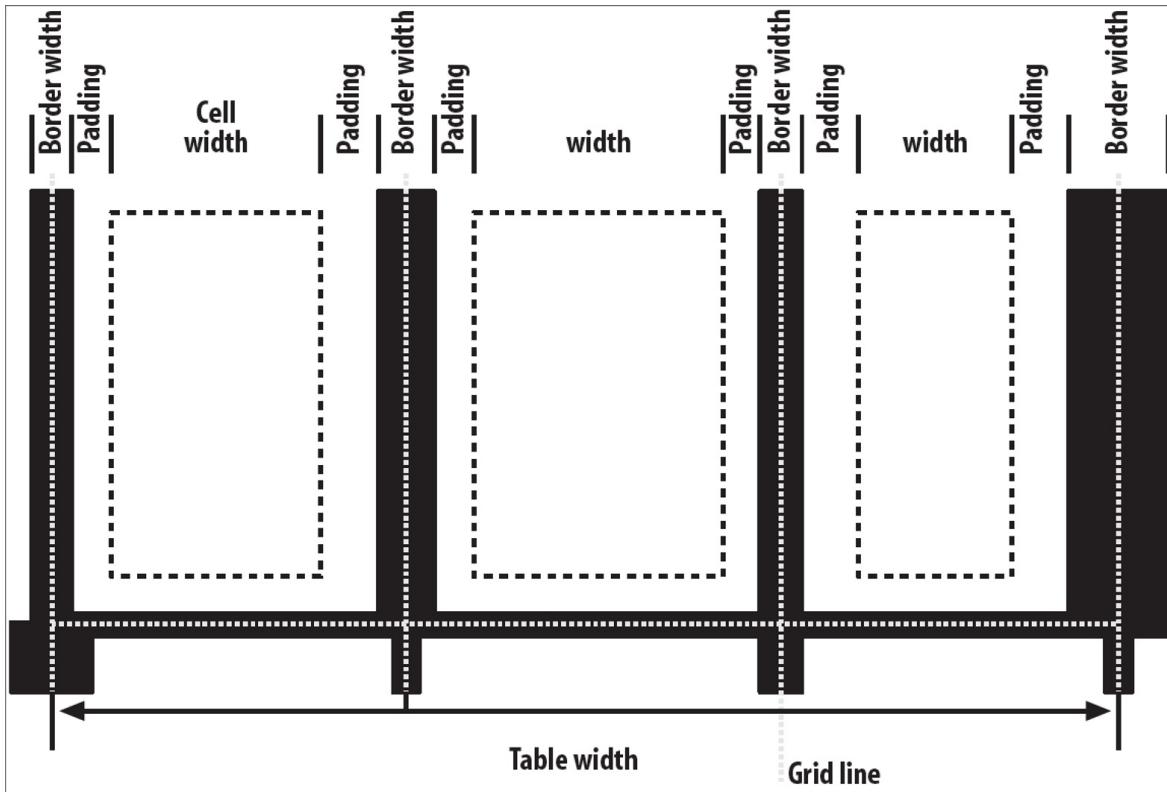
In order to better understand how the collapsing borders model works, let's look at the layout of a single table row, as shown in [Figure 7-8](#).

For each cell, the padding and content width of the cell is inside the borders, as expected. For the borders between cells, half of the border is to one side of

the grid line between two cells, and the other half is to the other side. In each case, only a single border is drawn along each cell edge. You might think that half of each cell's border is drawn to each side of the grid line, but that's not what happens.

For example, assume that the solid borders on the middle cell are green and the solid borders on the outer two cells are red. The borders on the right and left sides of the middle cell (which collapse with the adjacent borders of the outer cells) will be all green, or all red, depending on which border wins out. We'll discuss how to tell which one wins in the next section.

You may have noticed that the outer borders protrude past the table's width. This is because in this model, *half* the table's borders are included in the width. The other half sticks out beyond that distance, sitting in the margin itself. This might seem a bit weird, but that's how the model is defined to work.



**Figure 7-8.** The layout of a table row using the collapsing borders model

The specification includes a layout formula that I'll reproduce here for the benefit of those who enjoy such things:

$$\text{row width} = (0.5 * \text{border-width-0}) + \text{padding-left-1} + \text{width-1} + \text{padding-right-1} + \text{border-width-1} + \text{padding-left-2} + \dots + \text{padding-right-n} + (0.5 * \text{border-width-n})$$

Each `border-width-n` refers to the border between cell  $n$  and the next cell; thus, `border-width-3` refers to the border between the third and fourth cells. The value  $n$  stands for the total number of cells in the row.

There is a slight exception to this mechanism. When beginning the layout of a collapsed-border table, the user agent computes an initial left and right border for the table itself. It does this by examining the left border of the first cell in the first row of the table and by taking half of that border's width as the table's initial left border width. The user agent then examines the right border of the last cell in the first row and uses half that width to set the table's

initial right-border width. For any row after the first, if the left or right border is wider than the initial border widths, it sticks out into the margin area of the table.

In cases where a border is an odd number of display elements (pixels, printer dots, etc.) wide, the user agent is left to decide what to do about centering the border on the grid line. It might shift the border so that it is slightly off-center, round up or down to an even number of display elements, use anti-aliasing, or adjust anything else that seems reasonable.

## Border collapsing

When two or more borders are adjacent, they collapse into each other. In fact, they don't collapse so much as fight it out to see which of them will gain supremacy over the others. There are some strict rules governing which borders will win and which will not:

- If one of the collapsing borders has a `border-style` of `hidden`, it takes precedence over all other collapsing borders. All borders at this location are hidden.
- If all the borders are visible, then wider borders take precedence over narrower ones. Thus, if a two-pixel dotted border and a five-pixel double border collapse, the border at that location will be a five-pixel double border.
- If all collapsing borders have the same width but different border styles, then the border style is taken in the following order, from most to least preferred: `double`, `solid`, `dashed`, `dotted`, `ridge`, `outset`, `groove`, `inset`, `none`. Thus, if two borders with the same width are collapsing, and one is dashed while the other is `outset`, the border at that location will be dashed.
- If collapsing borders have the same style and width, but differ in color, then the color used is taken from an element in the following list, from most preferred to least: `cell`, `row`, `row group`, `column`, `column group`, `table`. Thus, if the borders of a cell and a column (identical in every way

except color) collapse, then the cell's border color (and style and width) will be used. If the collapsing borders come from the same type of element, such as two row borders with the same style and width but different colors, then the color is taken from borders that are further to the top and left (in left-to-right languages; otherwise, further to the top and right).

The following styles and markup, presented in [Figure 7-9](#), help illustrate each of the four rules:

```
table {border-collapse: collapse;
border: 3px outset gray;}
td {border: 1px solid gray; padding: 0.5em;}
#r2c1, #r2c2 {border-style: hidden;}
#r1c1, #r1c4 {border-width: 5px;}
#r2c4 {border-style: double; border-width: 3px;}
#r3c4 {border-style: dotted; border-width: 2px;}
#r4c1 {border-bottom-style: hidden;}
#r4c3 {border-top: 13px solid silver;}
```

1-1	1-2	1-3	1-4
2-1	2-2	2-3	2-4
3-1	3-2	3-3	3-4
4-1	4-2	4-3	4-4

```
</table>
```

Let's consider what happened for each of the cells, in turn:

- For cells 1-1 and 1-4, the five-pixel borders were wider than any of their adjacent borders, so they won out not only over adjoining cell borders, but over the border of the table itself. The only exception is the bottom of cell 1-1, which was suppressed.
- The bottom border on cell 1-1 was suppressed because cells 2-1 and 2-2, with their explicitly hidden borders, completely remove any borders from the edge of the cells. Again, the table's border lost out (on the left edge of cell 2-1) to a cell's border. The bottom border of cell 4-1 was also hidden, and so it prevented any border from appearing below the cell.
- The three-pixel double border of cell 2-4 was overridden on top by the five-pixel solid border of cell 1-4. Cell 2-4's border, in turn, overrode the border between itself and cell 2-3 because it was both wider and “more interesting.” Cell 2-4 also overrode the border between itself and cell 3-4, even though both are the same width, because 2-4's double style is defined to be “more interesting” than 3-4's dotted border.
- The 13-pixel bottom silver border of cell 3-3 not only overrode the top border of cell 4-3, but it also affected the layout of content within both cells *and* the rows that contain both cells.
- For cells along the outer edge of the table that aren't specially styled, their one-pixel solid borders are overridden by the three-pixel outset border on the table element itself.

1-1	1-2	1-3	1-4
2-1	2-2	2-3	2-4
3-1	3-2	3-3	3-4
4-1	4-2	4-3	4-4

Figure 7-9. Manipulating border widths, styles, and colors leads to some unusual results

This is, in fact, about as complicated as it sounds, although the behaviors are largely intuitive and make a little more sense with practice. It's worth noting, though, that the basic Netscape 1.1-era table presentation can be captured with a fairly simple set of rules, described here and illustrated by [Figure 7-10](#):

```
table {border-collapse: collapse; border: 2px outset gray;}
td {border: 1px inset gray;}
```

1-1	1-2	1-3	1-4
2-1	2-2	2-3	2-4
3-1	3-2	3-3	3-4
4-1	4-2	4-3	4-4

Figure 7-10. Reproducing old-school table presentation

# Table Sizing

Now that we've dug into the guts of table formatting and cell border appearance, we have the pieces we need to understand the sizing of tables and their internal elements. When it comes to determining table width, there are two different approaches: *fixed-width layout* and *automatic-width layout*. Heights are calculated automatically no matter what width algorithms are used.

# Width

Since there are two different ways to figure out the width of a table, it's only logical that there be a way to declare which should be used for a given table. Authors can use the property `table-layout` to select between the two kinds of table width calculation.

## **table-layout**

**Values:** auto | fixed | inherit

**Initial value:** auto

**Applies to:** Elements with the `display` value `table` or `inline-table`

**Inherited:** Yes

**Computed value:** As specified

While the two models can have different results in laying out a given table, the fundamental difference between the two is that of speed. With a fixed-width table layout, the user agent can calculate the layout of the table more quickly than is possible in the automatic-width model.

## **Fixed layout**

The main reason the fixed-layout model is so fast is that its layout does not depend on the contents of table cells. Instead, it's driven by the width values of the table, columns, and cells within that table.

The fixed-layout model works in the following simple steps:

1. Any column element whose `width` property has a value other than `auto` sets the width for that entire column.
  1. If a column has an `auto` width, but the cell in the first row of the table within that column has a `width` other than `auto`, then the cell sets the width for that entire column. If the cell spans multiple columns, then the width is divided between the columns.
  2. Any columns that are still auto-sized are sized so that their widths are as equal as possible.

At that point, the width of the table is set to be either the value of `width` for the table or the sum of the column widths, whichever is *greater*. If the table turns out to be wider than its columns, then the difference is divided by the number of columns and the result is added to each of them.

This approach is fast because all of the column widths are defined by the first row of the table. The cells in any rows that come after the first are sized according to the column widths that were defined by the first row. The cells in those following rows do not—indeed, cannot—change column widths, which means that any `width` value assigned to those cells will be ignored. In cases where a cell’s content does not fit into its cell, the `overflow` value for the cell determines whether the cell contents are clipped, visible, or generate a scrollbar.

Let’s consider the following styles and markup, which are illustrated in [Figure 7-11](#):

```
table {table-layout: fixed; width: 400px;
      border-collapse: collapse;}
td {border: 1px solid;}
col#c1 {width: 200px;}
#r1c2 {width: 75px;}
#r2c3 {width: 500px; }

<table>
  <colgroup> <col id="c1"><col id="c2"><col id="c3"><col id="c4">
  <tr>
```

```

<td id="r1c1">1-1</td>
<td id="r1c2">1-2</td>
<td id="r1c3">1-3</td>
<td id="r1c4">1-4</td>
</tr>
<tr>
    <td id="r2c1">2-1</td>
    <td id="r2c2">2-2</td>
    <td id="r2c3">2-3</td>
    <td id="r2c4">2-4</td>
</tr>
<tr>
    <td id="r3c1">3-1</td>
    <td id="r3c2">3-2</td>
    <td id="r3c3">3-3</td>
    <td id="r3c4">3-4</td>
</tr>
<tr>
    <td id="r4c1">4-1</td>
    <td id="r4c2">4-2</td>
    <td id="r4c3">4-3</td>
    <td id="r4c4">4-4</td>
</tr>
</table>

```

	200px	75px	61px	61px
1-1		1-2	1-3	1-4
2-1		2-2	2-3	2-4
3-1		3-2	3-3	3-4
4-1		4-2	4-3	4-4

**Figure 7-11.** Fixed-width table layout

As you can see in [Figure 7-11](#), the first column is 200 pixels wide, which happens to be half the 400-pixel width of the table. The second column is 75 pixels wide, because the first-row cell within that column has been assigned an explicit width. The third and fourth columns are each 61 pixels wide. Why? Because the sum of the column widths for the first and second columns (275 pixels), plus the various borders between columns (3 pixels), equals 278

pixels. 400 minus 278 is 122, and that divided in half is 61, so that's how many pixels wide the third and fourth columns will be. What about the 500-pixel width for `#r2c3`? It's ignored because that cell isn't in the first row of the table.

Note that it is not absolutely necessary that the table have an explicit `width` value to make use of the fixed-width layout model, although it definitely helps. For example, given the following, a user agent could calculate a width for the table that is 50 pixels narrower than the parent element's width. It would then use that calculated width in the fixed-layout algorithm:

```
table {table-layout: fixed; margin: 0 25px; width: auto;}
```

This is not required, however. User agents are also permitted to lay out any table with an `auto` value for `width` using the automatic-width layout model.

## Automatic layout

The automatic-width layout model, while not as fast as fixed layout, is probably much more familiar to you because it's substantially the same model that HTML tables have used for years. In most current user agents, use of this model will be triggered by a table having a `width` of `auto`, regardless of the value of `table-layout`, although this is not assured.

The reason automatic layout is slower is that the table cannot be laid out until the user agent has looked at all of the content in the table. That is, it requires that the user agent lay out the entire table in a fashion that takes the contents and styles of every cell into account. This generally requires the user agent to perform some calculations and then go back through the table to perform a second set of calculations.

The content has to be fully examined because, as with HTML tables, the table's layout is dependent on the content in all the cells. If there is a 400-pixel-wide image in a cell in the last row, then it will force all of the cells above it (those in the same column) to be at least 400 pixels wide. Thus, the width of every cell has to be calculated, and adjustments must be made (possibly triggering another round of content-width calculations) before the

table can be laid out.

The details of the model can be expressed in the following steps:

1. For each cell in a column, calculate both the minimum and maximum cell width.
  1. Determine the minimum width required to display the content. In determining this minimum content width, the content can flow to any number of lines, but it may not stick out of the cell's box. If the cell has a `width` value that is larger than the minimum possible width, then the minimum cell width is set to the value of `width`. If the cell's `width` value is `auto`, then the minimum cell width is set to the minimum content width.
  2. For the maximum width, determine the width required to display the content without any line breaking other than that forced by explicit line breaking (e.g., the `<br>` element). That value is the maximum cell width.
2. For each column, calculate both the minimum and maximum column width.
  1. The column's minimum width is determined by the largest minimum cell width of the cells within the column. If the column has been given an explicit `width` value that is larger than any of the minimum cell widths within the column, then the minimum column width is set to the value of `width`.
  2. For the maximum width, take the largest maximum cell width of the cells within the column. If the column has been given an explicit `width` value that is larger than any of the maximum cell widths within the column, then the maximum column width is set to the value of `width`. These two behaviors recreate the traditional HTML table behavior of forcibly expanding any column to be as wide as its widest cell.
3. In cases where a cell spans more than one column, then the sum of the

minimum column widths must be equal to the minimum cell width for the spanning cell. Similarly, the sum of the maximum column widths has to equal the spanning cell's maximum width. User agents should divide any changes in column widths equally among the spanned columns.

In addition, the user agent must take into account that when a column width has a percentage value for its width, the percentage is calculated in relation to the width of the table—even though it doesn't yet know what that will be! It instead has to hang on to the percentage value and use it in the next part of the algorithm.

At this point, the user agent will have figured how wide or narrow each column *can* be. With that information in hand, it can then proceed to actually figuring out the width of the table. This happens as follows:

1. If the computed width of the table is not `auto`, then the computed table width is compared to the sum of all the column widths *plus* any borders and cell spacing. (Columns with percentage widths are likely calculated at this time.) The larger of the two is the final width of the table. If the table's computed width is *larger* than the sum of the column widths, borders, and cell spacing, then the difference is divided by the number of columns and the result is added to each of them.
2. If the computed width of the table is `auto`, then the final width of the table is determined by adding up the column widths, borders, and cell spacing. This means that the table will be only as wide as needed to display its content, just as with traditional HTML tables. Any columns with percentage widths use that percentage as a constraint—but one that a user agent does not have to satisfy.

Once the last step is completed, then—and only then—can the user agent actually lay out the table.

The following styles and markup, presented in [Figure 7-12](#), help illustrate how this process works:

```
table {table-layout: auto; width: auto;}
```

```
border-collapse: collapse; }
td {border: 1px solid; padding: 0; }
col#c3 {width: 25%; }
#r1c2 {width: 40%; }
#r2c2 {width: 50px; }
#r2c3 {width: 35px; }
#r4c1 {width: 100px; }
#r4c4 {width: 1px; }

<table>
  <colgroup> <col id="c1"><col id="c2"><col id="c3"><col id="c4">
  <tr>
    <td id="r1c1">1-1</td>
    <td id="r1c2">1-2</td>
    <td id="r1c3">1-3</td>
    <td id="r1c4">1-4</td>
  </tr>
  <tr>
    <td id="r2c1">2-1</td>
    <td id="r2c2">2-2</td>
    <td id="r2c3">2-3</td>
    <td id="r2c4">2-4</td>
  </tr>
  <tr>
    <td id="r3c1">3-1</td>
    <td id="r3c2">3-2</td>
    <td id="r3c3">3-3</td>
    <td id="r3c4">3-4</td>
  </tr>
  <tr>
    <td id="r4c1">4-1</td>
    <td id="r4c2">4-2</td>
    <td id="r4c3">4-3</td>
    <td id="r4c4">4-4</td>
  </tr>
</table>
```

<i>100px</i>	<i>141px</i>	<i>88px</i>	<i>22px</i>
1-1	1-2	1-3	1-4
2-1	2-2	2-3	2-4
3-1	3-2	3-3	3-4
4-1	4-2	4-3	4-4

Figure 7-12. Automatic table layout

Let's consider what happened for each of the columns, in turn:

- For the first column, the only explicit cell or column width is that of cell 4-1, which was given a width of `100px`. Because the content is so short, both the minimum and maximum column widths are set to `100px`. (If there were a cell in the column with several sentences of text, it would have increased the maximum column width to whatever width necessary to display all of the text without line-breaking.)
- For the second column, two widths were declared: cell 1-2 was given a width of `40%`, and cell 2-2 was given a width of `50px`. The minimum width of this column is `50px`, and the maximum width is `40%` of the final table width.
- For the third column, only cell 3-3 had an explicit width (`35px`), but the column itself was given a width of `25%`. Therefore, the minimum column width is 35 pixels, and the maximum width is 25% of the final table width.
- For the fourth column, only cell 4-4 was given an explicit width (`1px`). This is smaller than the minimum content width, so both the minimum and maximum column widths are equal to the minimum content width of the cells. This turns out to be a computed 22 pixels, so the minimum and maximum widths are both 22 pixels.

The user agent now knows that the four columns have minimum and

maximum widths as follows:

- Minimum 100px, maximum 100px
  - Minimum 50px, maximum 40%
  - Minimum 35px, maximum 25%
  - Minimum 25px, maximum 22px

Thus, the table's minimum width is the sum of all the column minimums, plus the borders collapsed between the columns, which totals 215 pixels. The table's maximum width is  $123\text{px} + 65\%$ , where the  $123\text{px}$  comes from the first and last columns and their shares of the collapsed borders. This maximum works out to be 351.42857142857143 pixels (given that  $123\text{px}$  represents 35% of the overall table width). With this number in hand, the second column will be 140.5 pixels wide, and the third column will be 87.8 pixels wide. These may be rounded by the user agent to whole numbers such as  $141\text{px}$  and  $88\text{px}$ , or not, depending on the exact rendering method used. (These are the numbers used in [Figure 7-12](#).)

Note that it is not required that user agents actually use the maximum value; they may choose another course of action.

Of course, this was (although it may not seem like it) a very simple and straightforward example: all of the content was basically the same width, and most of the declared widths were pixel lengths. In a situation where a table contains images, paragraphs of text, form elements, and so forth, the process of figuring out the table's layout is likely to be a great deal more complicated.

# Height

After all of the effort that was expended in figuring out the width of the table, you might well wonder how much more complicated height calculation will be. Actually, in CSS terms, it's pretty simple, although browser developers probably don't think so.

The easiest situation to describe is one in which the table height is explicitly set via the `height` property. In such cases, the height of the table is defined by the value of `height`. This means that a table may be taller or shorter than the sum of its row heights. Note that `height` is treated much more like `min-height` for tables, so if you define a `height` value that's smaller than the sum total of the row heights, it may appear to be ignored.

By contrast, if the `height` value of a table is greater than the total of its row heights, the specification explicitly refuses to define what should happen, instead noting that the issue may be resolved in future versions of CSS. A user agent could expand the table's rows to fill out its height, or leave blank space inside the table's box, or something completely different. It's up to each user agent to decide.

## Note

As of mid-2016, the most common behavior of user agents was to increase the heights of the rows in a table to fill out its overall height. This was accomplished by taking the difference between the table height and the sum of the row heights, dividing it by the number of rows, and applying the resulting amount to each row.

If the `height` of the table is `auto`, then its height is the sum of the heights of all the rows within the table, plus any borders and cell spacing. To determine the height of each row, the user agent goes through a process similar to that used to find the widths of columns. It calculates a minimum and maximum height for the contents of each cell and then uses these to derive a minimum and maximum height for the row. After having done this for all the rows, the

user agent figures out what each row's height should be, stacks them all on top of one another, and uses the total to determine the table's height. It's a lot like inline layout, only with less certainty in how things should be done.

In addition to what to do about tables with explicit heights and how to treat row heights within them, you can add the following to the list of things CSS does not define:

- The effect of a percentage height for table cells.
- The effect of a percentage height for table rows and row groups.
- How a row-spanning cell affects the heights of the rows that are spanned, except that the rows have to contain the spanning cell.

As you can see, height calculations in tables are largely left up to user agents to figure out. Historical evidence would suggest that this will lead to each user agent doing something different, so you should probably avoid setting table heights as much as possible.

# Alignment

In a rather interesting turn of events, alignment of content within cells is a lot better defined than cell and row heights. This is true even for vertical alignment, which can quite easily affect the height of a row.

Horizontal alignment is the simplest. To align content within a cell, you use the `text-align` property. In effect, the cell is treated as a block-level box, and all of the content within it is aligned as per the `text-align` value.

To vertically align content in a table cell, `vertical-align` is the relevant property. It uses many of the same values that are used for vertically aligning inline content, but the meanings of those values change when applied to a table cell. To summarize the three simplest cases:

`top`

The top of the cell's content is aligned with the top of its row; in the case of row-spanning cells, the top of the cell's content is aligned with the top of the first row it spans.

`bottom`

The bottom of the cell's content is aligned with the bottom of its row; in the case of row-spanning cells, the bottom of the cell's content is aligned with the bottom of the last row it spans.

`middle`

The middle of the cell's content is aligned with the middle of its row; in the case of row-spanning cells, the middle of the cell's content is aligned with the middle of all the rows it spans.

These are illustrated in [Figure 7-13](#), which uses the following styles and markup:

```
table {table-layout: auto; width: 20em;
```

```

border-collapse: separate; border-spacing: 3px; }
td {border: 1px solid; background: silver;
    padding: 0; }
div {border: 1px dashed gray; background: white; }
#r1c1 {vertical-align: top; height: 10em; }
#r1c2 {vertical-align: middle; }
#r1c3 {vertical-align: bottom; }

<table>
  <tr>
    <td id="r1c1">
      <div>
        The contents of this cell are top-aligned.
      </div>
    </td>
    <td id="r1c2">
      <div>
        The contents of this cell are middle-aligned.
      </div>
    </td>
    <td id="r1c3">
      <div>
        The contents of this cell are bottom-aligned.
      </div>
    </td>
  </tr>
</table>

```

<p>The contents of this cell are top-aligned.</p>	<p>The contents of this cell are middle-aligned.</p>	<p>The contents of this cell are bottom-aligned.</p>
---	--	--

Figure 7-13. Vertical alignment of cell contents

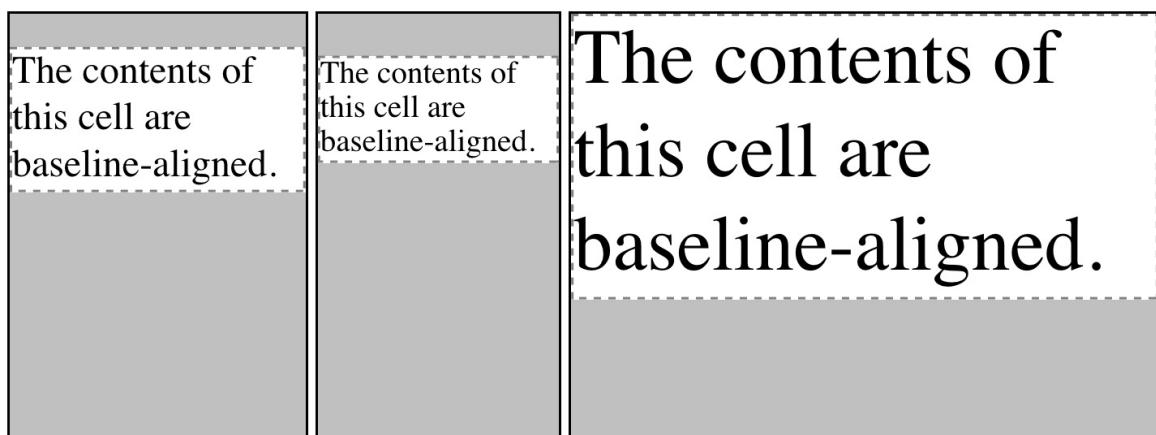
In each case, the alignment is carried out by automatically increasing the padding of the cell itself to achieve the desired effect. In the first cell in [Figure 7-13](#), the bottom padding of the cell has been changed to equal the difference between the height of the cell's box and the height of the content within the cell. For the second cell, the top and bottom padding of the cell have been reset to be equal, thus vertically centering the content of the cell. In the last cell, the cell's top padding has been altered.

The fourth possible value alignment is `baseline`, and it's a little more complicated than the first three:

`baseline`

The baseline of the cell is aligned with the baseline of its row; in the case of row-spanning cells, the baseline of the cell is aligned with the baseline of the first row it spans.

It's easiest to provide an illustration ([Figure 7-14](#)) and then discuss what's happening.



**Figure 7-14.** Baseline alignment of cell contents

A row's baseline is defined by the lowest initial cell baseline (that is, the baseline of the first line of text) out of all its cells. Thus, in [Figure 7-14](#), the row's baseline was defined by the third cell, which has the lowest initial baseline. The first two cells then have the baseline of their first line of text aligned with the row's baseline.

As with top, middle, and bottom alignment, the placement of baseline-aligned cell content is accomplished by altering the top and bottom padding of the cells. In cases where none of the cells in a row are baseline-aligned, the row does not even have a baseline—it doesn't really need one.

The detailed process for aligning cell contents within a row is as follows:

1. If any of the cells are baseline-aligned, then the row's baseline is determined and the content of the baseline-aligned cells is placed.
  1. Any top-aligned cell has its content placed. The row now has a provisional height, which is defined by the lowest cell bottom of the cells that have already had their content placed.
  2. If any remaining cells are middle- or bottom-aligned, and the content height is taller than the provisional row height, the height of the row is increased to enclose the tallest of those cells.
  3. All remaining cells have their content placed. In any cell whose contents are shorter than the row height, the cell's padding is increased in order to match the height of the row.

The vertical-align values `sub`, `super`, `text-top`, and `text-bottom` are supposed to be ignored when applied to table cells. Instead, they seem to all treated as if they are `baseline`, or possibly `top`.

# Summary

Even if you're quite familiar with table layout from years of table-and-spacer design, it turns out that the mechanisms driving such layout are rather complicated. Thanks to the legacy of HTML table construction, the CSS table model is row-centric, but it does, thankfully, accommodate columns and limited column styling. Thanks to new abilities to affect cell alignment and table width, you now have even more tools for presenting tables in a pleasing way.

The ability to apply table-related display values to arbitrary elements opens the door to creating table-like layouts using HTML elements such as `div` and `section`, or in XML languages where any element could be used to describe table components.

# Chapter 8. Transforms

Ever since the inception of Cascading Style Sheets (CSS), elements have been rectangular and firmly oriented on the horizontal and vertical axes. A number of tricks arose to make elements look like they were tilted and so on, but underneath it all was a rigid grid. In the late 2000s, an interest grew in being able to break the shackles of that grid and transform objects in interesting ways—and not just in two dimensions.

If you've ever positioned an object, whether relatively or absolutely, then you've already transformed that object. For that matter, any time you used floats or negative-margin tricks (or both), you transformed an object. All of those are examples of *translation*, or the movement of an element from where it would normally appear to some other place. With CSS transforms, you have a new way to translate elements, and a whole lot more. Whether it's as simple as rotating some photographs a bit to make them appear more natural, or creating interfaces where information can be revealed by flipping over elements, or just doing interesting perspective tricks with sidebars, CSS transforms can—if you'll pardon the obvious expression—transform the way you design.

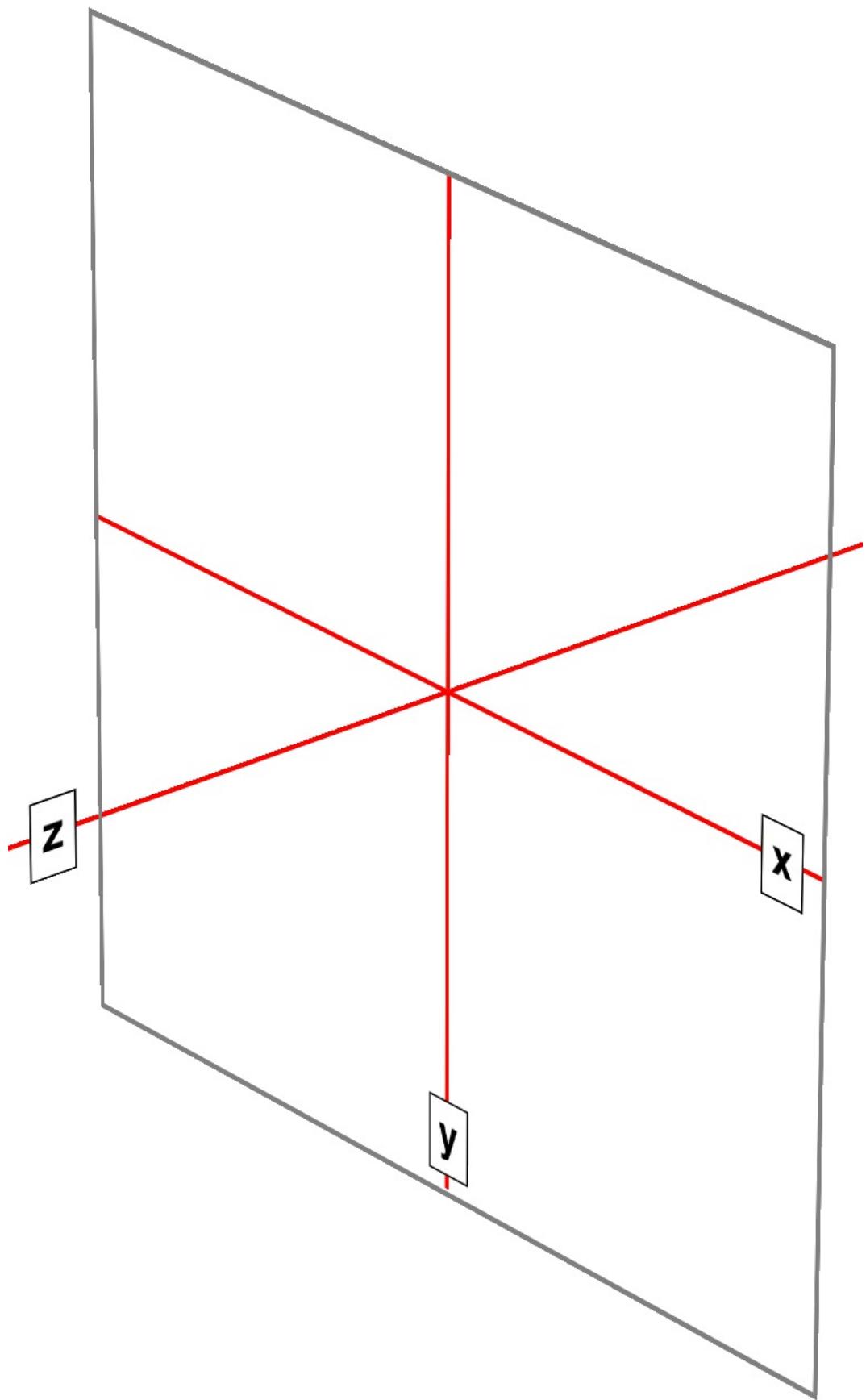
# Coordinate Systems

Before embarking on this journey, let's take a moment to orient ourselves. Two types of coordinate systems are used in transforms, and it's a good idea to be familiar with both.

## Note

If you're already well familiar with Cartesian and spherical coordinate systems, particularly as used in computing, feel free to skip to the next section.

The first is the Cartesian coordinate system, or what's often called the x/y/z coordinate system. This system is a way of describing the position of a point in space using two numbers (for two-dimensional placement) or three numbers (for three-dimensional placement). In CSS, the system uses three axes: the x, or horizontal axis; the y, or vertical axis; and the z, or depth axis. This is illustrated in [Figure 1-1](#).



**Figure 8-1.** The three Cartesian axes used in CSS transforms

For any 2D (two-dimensional) transform, you only need to worry about the x- and y-axes. By convention, positive x values go to the right, and negative values go to the left. Similarly, positive y values go downward along the y-axis, while negative values go upward along the y-axis.

That might seem a little weird, since we tend to think that higher numbers should place something higher up, not lower down, as many of us learned in pre-algebra. (This why the “y” label is at the bottom of the y-axis in [Figure 1-1](#): the labels are placed in the positive direction on all three axes.) If you are experienced with absolute positioning in CSS, think of the *top* property values for absolutely positioned elements: they get moved downward for positive *top* values, and upward when *top* has a negative length.

Given this, in order to move an element leftward and down, you would give it a negative x and a positive y value, like this:

```
translateX(-5em) translateY(33px)
```

That is in fact a valid transform value, as we’ll see in just a bit. Its effect is to translate (move) the element five ems to the left and 33 pixels down.

If you want to transform something in three-dimensional space, then you add a z-axis value. This axis is the one that “sticks out” of the display and runs straight through your head. In a theoretical sense, that is. Positive z values are closer to you, and negative z values are further away from you. In this regard, it’s exactly like the `z-index` property.

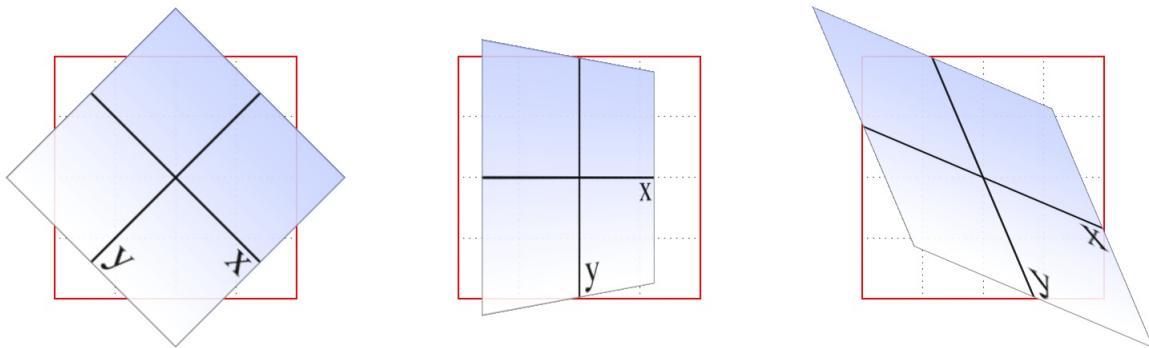
So let’s say that we want to take the element we moved before and add a z-axis value:

```
translateX(-5em) translateY(33px) translateZ(200px)
```

Now the element will appear 200 pixels closer to us than it would be without the z value.

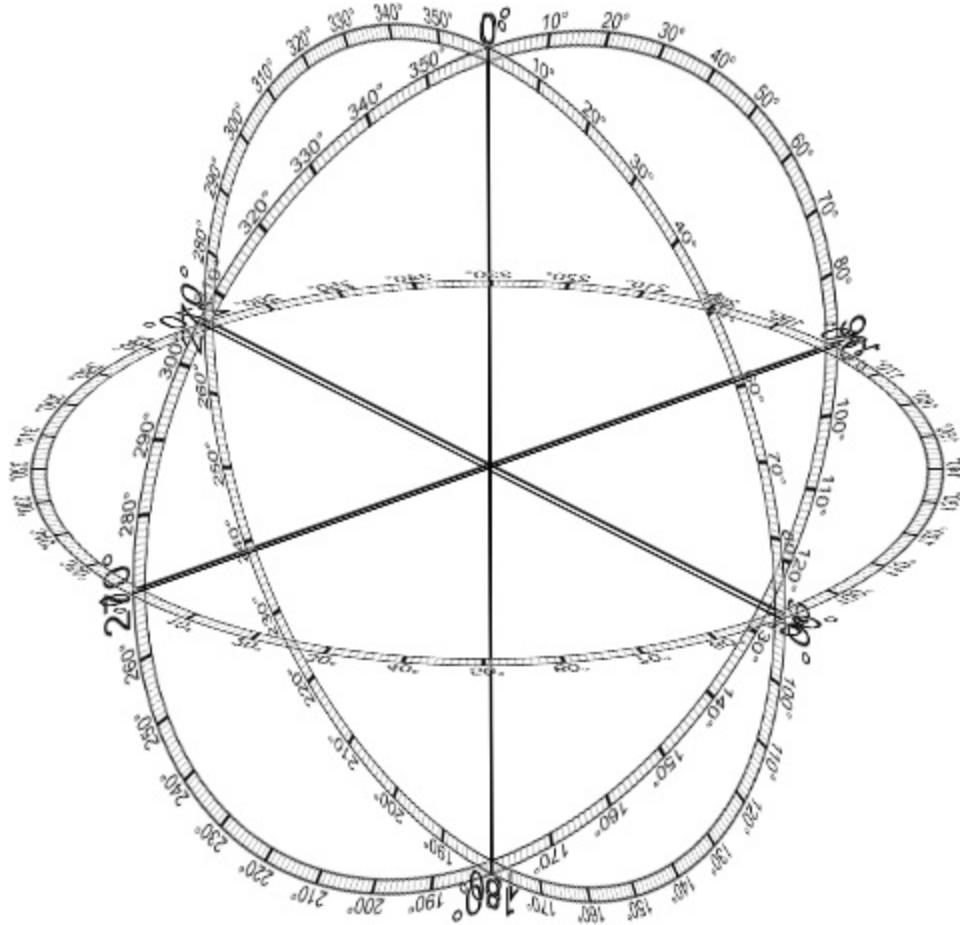
Well you might wonder exactly how an element can be moved 200 pixels closer to you, given that holographic displays are regrettably rare and expensive. How many molecules of air between you and your monitor are equivalent to 200 pixels? What does an element moving closer to you even look like, and what happens if it gets *too* close? These are excellent questions that we'll get to later on. For now, just accept that moving an element along the z-axis appears to move it closer or farther away.

The really important thing to remember is that every element carries its own frame of reference and so considers its axes with respect to itself. That is to say, if you rotate an element, the axes rotate along with it, as illustrated in [Figure 1-2](#). Any further transforms are calculated with respect to those rotated axes, not the axes of the display.



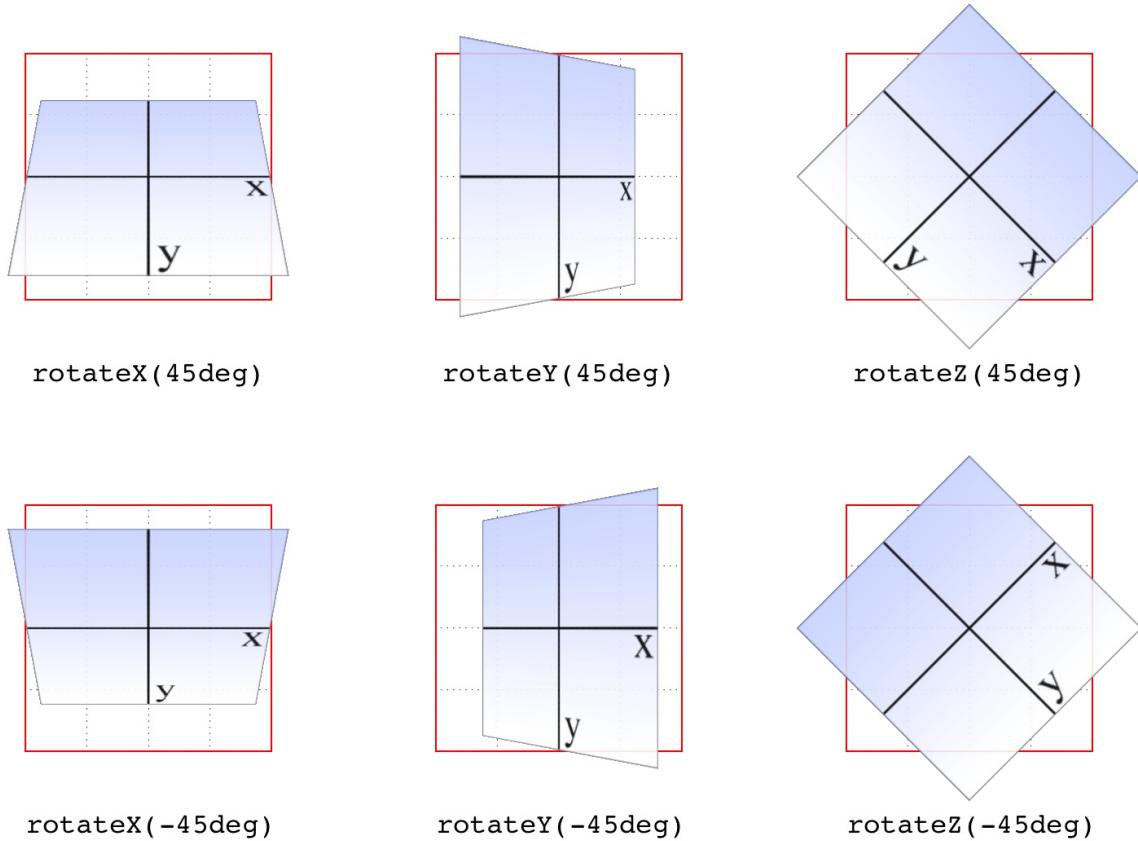
**Figure 8-2. Elemental frames of reference**

Speaking of rotations, the other coordinate system used in CSS transforms is a spherical system, which describes angles in 3D space. It's illustrated in [Figure 1-3](#).



**Figure 8-3.** The spherical coordinate system used in CSS transforms

For the purposes of 2D transforms, you only have to worry about a single 360-degree polar system: the one that sits on the plane described by the x- and y-axes. When it comes to rotations, a 2D rotation actually describes a rotation around the z-axis. Similarly, rotations around the x-axis tilt the element toward or away from you, and rotations around the y-axis turn the element from side to side. These are illustrated in [Figure 1-4](#).

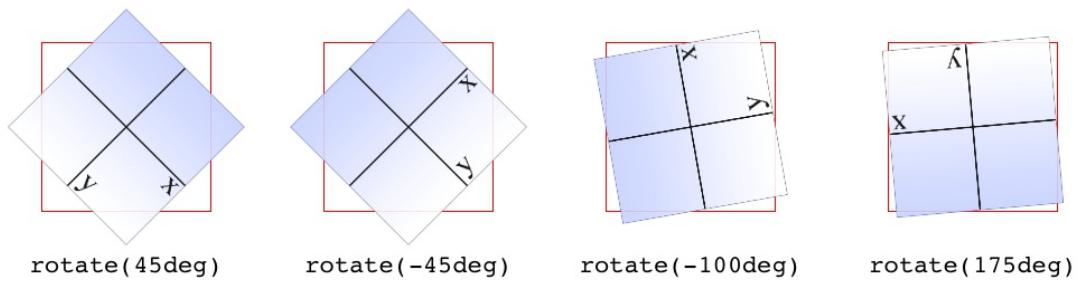


**Figure 8-4. Rotations around the three axes**

But back to 2D rotations. Suppose you wanted to rotate an element 45 degrees clockwise in the plane of the display (i.e., around the z-axis). The transform value you're most likely to use is:

`rotate(45deg)`

Change that to `-45deg`, and the element will rotate counterclockwise (anticlockwise for our international friends) around the z-axis. In other words, it will rotate in the xy plane, as illustrated in [Figure 1-5](#).



**Figure 8-5. Rotations in the xy plane**

All right, now that we have our bearings, let's get started with transforms!

# Transforming

There's really only one property that applies transforms, along with a few ancillary properties that affect exactly how the transforms are applied. We'll start with the Big Cheese.

## transform

**Values:** <transform-list> | none | inherit

**Initial value:** none

**Applies to:** All elements except “atomic inline-level” boxes (see explanation)

**Inherited:** No

**Percentages:** Refer to the size of the bounding box (see explanation)

**Computed value:** As specified, except for relative length values, which are converted to an absolute length

First off, let's clear up the matter of the *bounding box*. For any element being affected by CSS, this is the border box; that is, the outermost edge of the element's border. That means that any outlines and margins are ignored for the purposes of calculating the bounding box.

**Note**

If a table-display element is being transformed, its bounding box is the table wrapper box, which encloses the table box and any associated caption box.

If you're transforming a Scalable Vector Graphics (SVG) element with CSS, then its bounding box is its SVG-defined *object bounding box*. Simple enough!

Note that all transformed elements (i.e., elements with `transform` set to a value other than `none`) have their own stacking context. While the scaled element may be much smaller or larger than it was before the transform was applied, the actual space on the page that the element occupies remains the same as before the transform was applied. This is true for all the transform functions.

Now, the value entry `<transform-list>` requires some explanation. This placeholder refers to a list of one or more transform functions, one after the other, in space-separated format. It looks like this, with the result shown in [Figure 1-6](#):

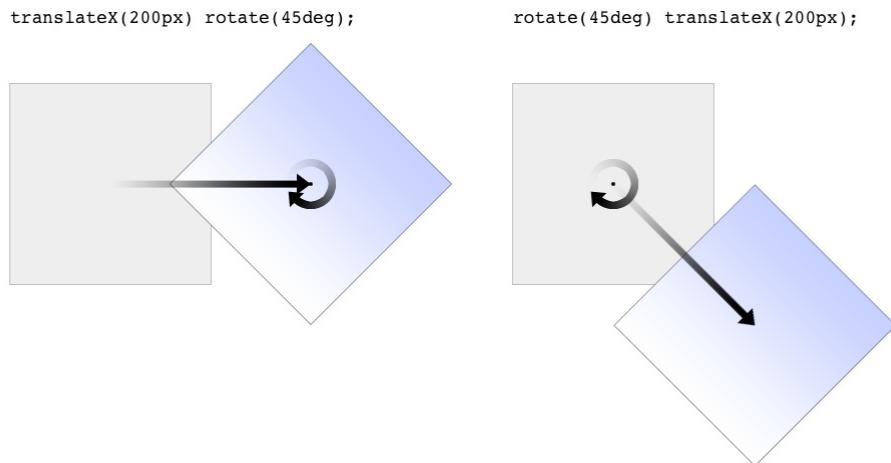
```
#example {transform: rotate(30deg) skewX(-25deg) scaleY(2);}
```



**Figure 8-6.** A transformed div element

The functions are processed one at a time, starting with the first (leftmost) and proceeding to the last (rightmost). This first-to-last processing order is important, because changing the order can lead to drastically different results. Consider the following two rules, which have the results shown in [Figure 1-7](#):

```
img#one {transform: translateX(200px) rotate(45deg);}  
img#two {transform: rotate(45deg) translateX(200px);}
```



**Figure 8-7. Different transform lists, different results**

In the first instance, an image is translated (moved) 200 pixels along its x-axis and then rotated 45 degrees. In the second instance, an image is rotated 45 degrees and then moved 200 pixels along its x-axis—that’s the x-axis of the transformed element, *not* of the parent element, page, or viewport. In other words, when an element is rotated, its x-axis (along with its other axes) rotates along with it. All element transforms are conducted with respect to the element’s own frame of reference.

Compare this to a situation where an element is translated and then scaled, or vice versa; it doesn’t matter which is which, because the end result is the same:

```
img#one {transform: translateX(100px) scale(1.2);}  
img#two {transform: scale(1.2) translateX(100px);}
```

The situations where the order doesn’t matter are far outnumbered by the situations where it does; so in general, it’s a good idea to just assume the order always matters, even when it technically doesn’t.

Note that when you have a series of transform functions, all of them must be properly formatted; that is, they must be valid. If even one function is invalid,

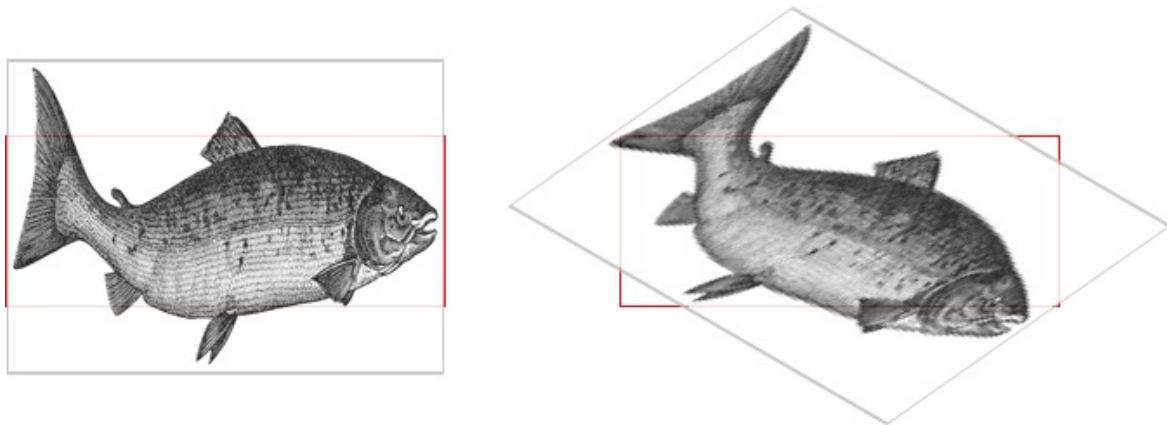
it renders the entire value invalid. Consider:

```
img#one {transform: translateX(100px) scale(1.2) rotate(22);}
```

Because the value for `rotate()` is invalid—rotational values must have a unit—the entire value is dropped. The image in question will simply sit there in its initial untransformed state, neither translated nor scaled, let alone rotated.

It's also the case that transforms are not usually cumulative. That is to say, if you apply a transform to an element and then later want to add a transformation, you need to restate the original transform. Consider the following scenarios, illustrated in [Figure 1-8](#):

```
#ex01 {transform: rotate(30deg) skewX(-25deg);}  
#ex01 {transform: scaleY(2);}  
#ex02 {transform: rotate(30deg) skewX(-25deg);}  
#ex02 {transform: rotate(30deg) skewX(-25deg) scaleY(2);}
```



**Figure 8-8. Overwriting or modifying transforms**

In the first case, the second rule completely replaces the first, meaning that the element is only scaled along the y-axis. This actually makes some sense; it's the same as if you declare a font size and then elsewhere declare a different font size for the same element. You don't get a cumulative font size that way. You just get one size or the other. In the second example, the entirety of the first set of transforms is included in the second set, so they all are applied along with the `scaleY()` function.

There is an exception to this, which is that animated transforms, whether

using transitions or actual animations, *are* additive. That way, you can take an element that's transformed and then animate one of its transform functions without overwriting the others. For example, assume you had:

```
img#one {transform: translateX(100px) scale(1.2);}
```

If you then animate the element's rotation angle, it will rotate from its translated, scaled state to the new angle, and its translation and scale will remain in place.

What makes this interesting is that even if you don't explicitly specify a transition or animation, you can still create additive transforms via the user-interaction pseudoclasses, such as `:hover`. That's because things like hover effects are types of transitions; they're just not invoked using the transition properties. Thus, you could declare:

```
img#one {transform: translateX(100px) scale(1.2);}  
img#one:hover {transform: rotate(-45deg);}
```

This would rotate the translated, scaled image 45 degrees to its left on hover. The rotation would take place over zero seconds because no transition interval was declared, but it's still an implicit transition. Thus, any state change can be thought of as a transition, and thus any transforms that are applied as a result of those state changes are additive with previous transforms.

There's one important caveat: as of this writing, transforms are not applied to "atomic inline-level" boxes. These are inline boxes like spans, hyperlinks, and so on. Those elements can be transformed if their block-level parent is transformed, in which case they go along for the ride. But you can't just rotate a `span` unless you've changed its display role via `display: block`, `display: inline-block`, or something along those lines. The reason for this limitation boils down to an uncertainty. Suppose you have a `span` (or any inline-level box) that breaks across multiple lines. If you rotate it, what happens? Does each line box rotate with respect to itself, or should all the line boxes be rotated as a single group? There's no clear answer, and the debate continues, so for now you can't directly transform inline-level boxes.

**Note**

As of late 2014, `transform` and its associated properties still had to be vendor-prefixed in WebKit and Blink browsers like Safari and Chrome. No prefixes were needed in other major user agents. This restriction was finally dropped in early 2015.

# The Transform Functions

There are, as of this writing, 21 different transform functions, employing a number of different value patterns to get their jobs done. [Table 2-1](#) provides a list of all the available transform functions, minus their value patterns.

Table 8-1. Transform functions

```
translate()    scale()    rotate()  
  
translate3d()  scale3d()  rotate3d() skew()   matrix()  
  
translateX()   scaleX()   rotateX()  skewX()  matrix3d()  
  
translateY()   scaleY()   rotateY()  skewY()  perspective()  
  
translateZ()   scaleZ()   rotateZ()
```

As previously stated, the most common value pattern for `transform` is a space-separated list of one or more functions, processed from first (leftmost) to last (rightmost), and all of the functions must have valid values. If any one of the functions is invalid, it will invalidate the entire value of `transform`, thus preventing any transformation at all.

## Translation functions

A translation transform is just a move along one or more axes. For example, `translateX()` moves an element along its own x-axis, `translateY()` moves it along its y-axis, and `translateZ()` moves it along its z-axis.

Functions	Permitted values
<code>translateX()</code> , <code>translateY()</code>	<code>&lt;length&gt;</code>   <code>&lt;percentage&gt;</code>

These are usually referred to as the “2D” translation functions, since they can slide an element up and down, or side to side, but not forward or backward along the z-axis. Each of these functions accepts a single distance value, expressed as either a length or a percentage.

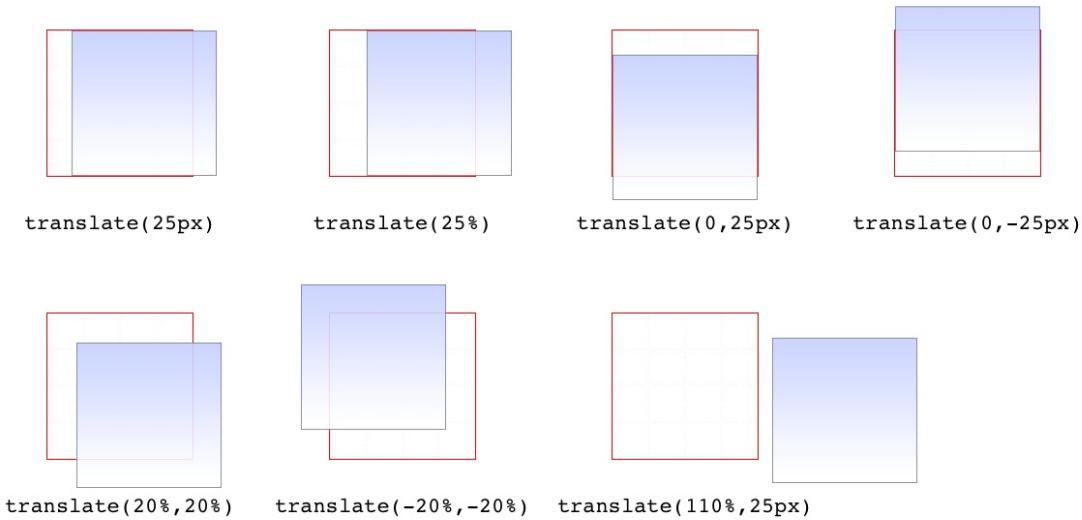
If the value is a length, then the effect is about what you’d expect. Translate an element 200 pixels along the x-axis with `translateX(200px)`, and it will move 200 pixels to its right. Change that to `translateX(-200px)`, and it will move 200 pixels to its left. For `translateY()`, positive values move the element downward, while negative values move it upward, both with respect to the element itself. Thus, if you flip the element upside down by rotation, positive `translateY()` values will actually move the element downward on the page.

If the value is a percentage, then the distance is calculated as a percentage of the element’s own size. Thus, `translateX(50%)` will move an element 300 pixels wide and 200 pixels tall to its right by 150 pixels, and `translateY(-10%)` will move that same element upward (with respect to itself) by 20 pixels.

Function	Permitted values
----------	------------------

`translate()` [`<length>` | `<percentage>`] [, `<length>` | `<percentage>`] ?

If you want to translate an element along both the x- and y-axes at the same time, then `translate()` makes it simple. Just supply the x value first and the y value second, and it will act the same as if you combined `translateX()` `translateY()`. If you omit the y value, then it’s assumed to be zero. Thus, `translate(2em)` is treated as if it were `translate(2em, 0)`, which is also the same as `translateX(2em)`. See [Figure 1-9](#) for some examples of 2D translation.



**Figure 8-9. Translating in two dimensions**

According to the latest version of the specification, both of the 2D translation functions can be given a unitless number. In this case, the number is treated as being expressed in terms of a “user unit,” which is treated the same as a pixel unless otherwise defined. The CSS specification does not explain how a user unit is otherwise defined; however, the SVG specification does, albeit briefly. In the field, no browser tested as of this writing supported unitless numbers of translation values, so the capability is academic, at best.

## Function    Permitted value

`translateZ()` `<length>`

This function translates elements along the z-axis, thus moving them into the third dimension. Unlike the 2D translation functions, `translateZ()` only accepts length values. Percentage values are *not* permitted for `translateZ()`, or indeed for any z-axis value.

## Functions

## Permitted values

[ `<length>` | `<percentage>` ], [ `<length>` |

```
translate3d() <percentage>], [ <length> ]
```

Much like `translate()` does for x and y translations, `translate3d()` is a shorthand function that incorporates the x, y, and z translation values into a single function. This is obviously handy if you want to move an element over, up, and forward in one fell swoop. See [Figure 1-10](#) for an illustration of how 3D translation works. There, each arrow represents the translation along that axis, arriving at a point in 3D space. The dashed lines show the distance and direction from the origin point (the intersection of the three axes) and the distance above the xz plane.

Unlike `translate()`, there is no fallback for situations where `translate3d()` does not contain three values. Thus, `translate3d(1em, -50px)` should be treated as invalid by user agents instead of being assumed to be `translate3d(2em, -50px, 0)`.

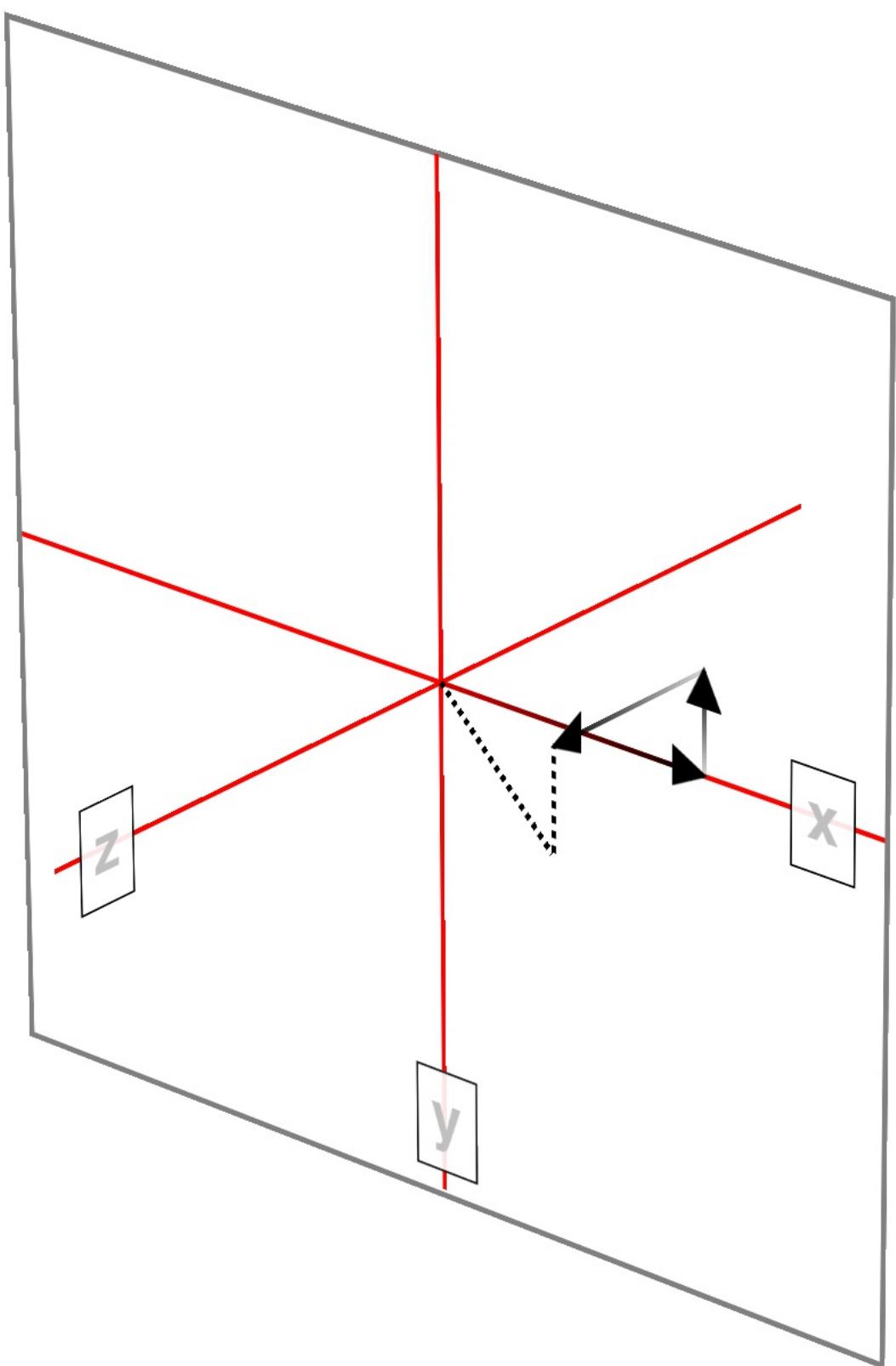
## Scale functions

A scale transform makes an element larger or smaller, depending on what value you use. These values are unitless real numbers and are always positive. On the 2D plane, you can scale along the x- and y-axes individually, or scale them together.

### Functions

### Permitted value

```
scaleX(), scaleY(), scaleZ() <number>
```



`translate3d(150px, -50px, 100px)`

**Figure 8-10.** Translating in three dimensions

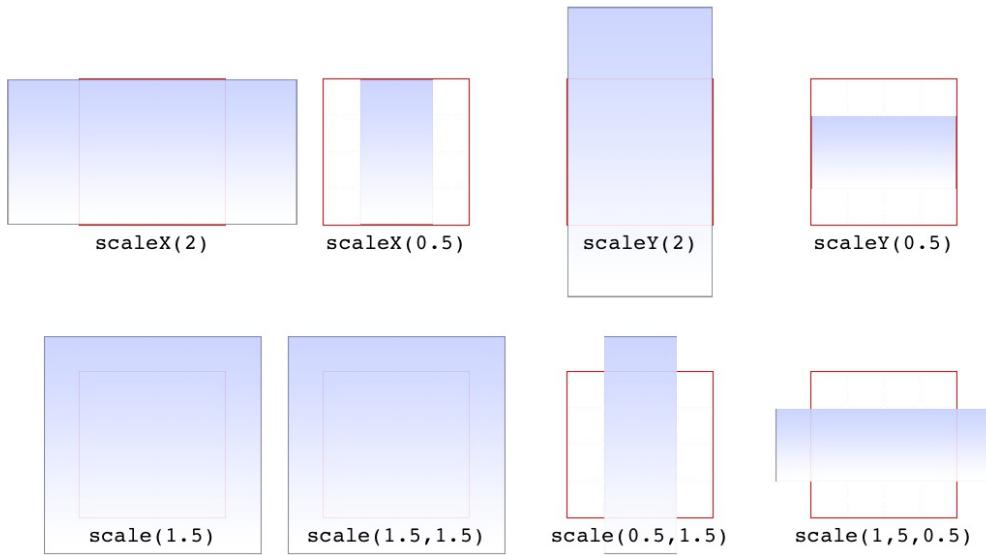
The number value supplied to a scale function is a multiplier; thus, `scaleX(2)` will make an element twice as wide as it was before the transformation, whereas `scaleY(0.5)` will make it half as tall. Given this, you might expect that percentage values are permissible as scaling values, but they aren't.

Function	Permitted value
----------	-----------------

<code>scale()</code>	<code>&lt;number&gt; [, &lt;number&gt;]?</code>
----------------------	---

If you want to scale along both axes simultaneously, use `scale()`. The x value is always first and the y always second, so `scale(2, 0.5)` will make the element twice as wide and half as tall as it was before being transformed. If you only supply one number, it is used as the scaling value for both axes; thus, `scale(2)` will make the element twice as wide *and* twice as tall. This is in contrast to `translate()`, where an omitted second value is always set to zero. `scale(1)` will scale an element to be exactly the same size it was before you scaled it, as will `scale(1, 1)`. Just in case you were dying to do that.

[Figure 1-11](#) shows a few examples of element scaling, using both the single-axis scaling functions, as well as the combined `scale()`.



**Figure 8-11. Scaled elements**

Of course, if you can scale in two dimensions, you can also scale in three. CSS offers `scaleZ()` for scaling just along the z-axis, and `scale3d()` for scaling along all three axes at once. These really only have an effect if the element has any depth, which elements don't by default. If you do make a change that conveys depth—say, rotating an element around the x- or y-axes—then there is a depth that can be scaled, and either `scaleZ()` or `scale3d()` can do so.

<b>Function</b>	<b>Permitted value</b>
-----------------	------------------------

`scale3d() <number>, <number>, <number>`

Similar to `translate3d()`, `scale3d()` requires all three numbers to be valid. If you fail to do this, then the malformed `scale3d()` will invalidate the entire transform value to which it belongs.

## Rotation functions

A rotation function causes an element to be rotated around an axis, or around

an arbitrary vector in 3D space. There are four simple rotation functions, and one less-simple function meant specifically for 3D.

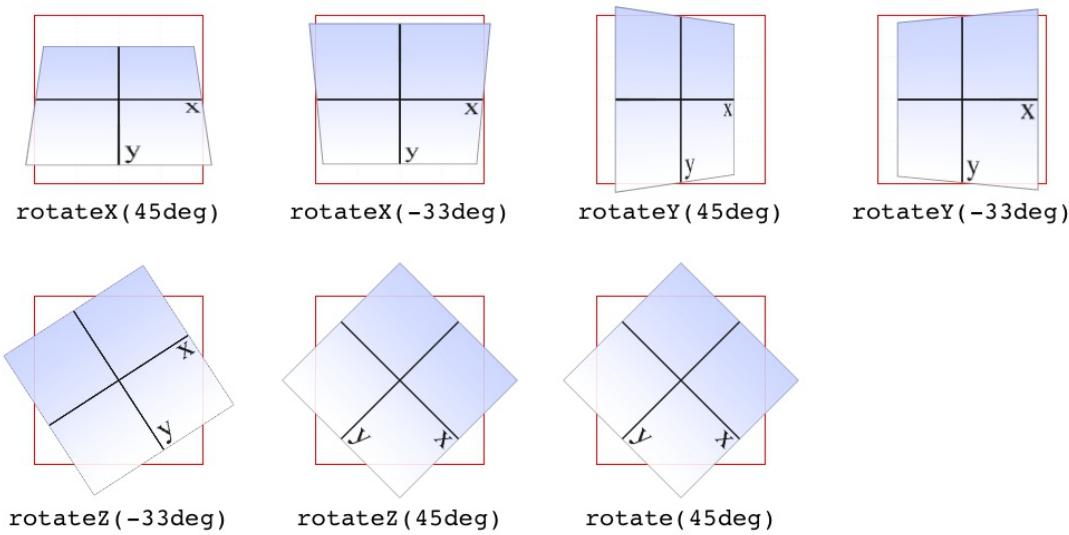
Functions	Permitted values
-----------	------------------

<code>rotate()</code> , <code>rotateX()</code> , <code>rotateY()</code> , <code>rotateZ()</code> <angle>	
--	--

All four basic rotation functions accept just one value: a degree. This can be expressed using any of the valid degree units (`deg`, `grad`, `rad`, and `turn`) and a number, either positive or negative. If a value's number runs outside the usual range for the given unit, it will be normalized to fit into the accepted range. In other words, a value of `437deg` will be tilted the same as if it were `77deg`, or, for that matter, `-283deg`.

Note, however, that these are only exactly equivalent if you don't animate the rotation in some fashion. That is to say, animating a rotation of `1100deg` will spin the element around several times before coming to rest at a tilt of -20 degrees (or 340 degrees, if you like). By contrast, animating a rotation of `-20deg` will tilt the element a bit to the left, with no spinning; and of course animating a rotation of `340deg` will animate an almost-full spin to the right. All three animations come to the same end state, but the process of getting there is very different in each case.

The function `rotate()` is a straight 2D rotation, and the one you're most likely to use. It is equivalent to `rotateZ()` because it rotates the element around the z-axis (the one that shoots straight out of your display and through your eyeballs). In a similar manner, `rotateX()` causes rotation around the x-axis, thus causing the element to tilt toward or away from you; and `rotateY()` rotates the element around its y-axis, as though it were a door. These are all illustrated in [Figure 1-12](#).



**Figure 8-12.** Rotations around the three axes

#### Warning

Several of the examples in [Figure 1-12](#) present a fully 3D appearance. This is only possible with certain values of the properties `transform-style` and `perspective`, described in a later section and omitted here for clarity. This will be true throughout this text in any situation where 3D-transformed elements appear to be fully three-dimensional. This is important to keep in mind because if you just try to apply the transform functions shown, you won't get the same visual results as in the figures.

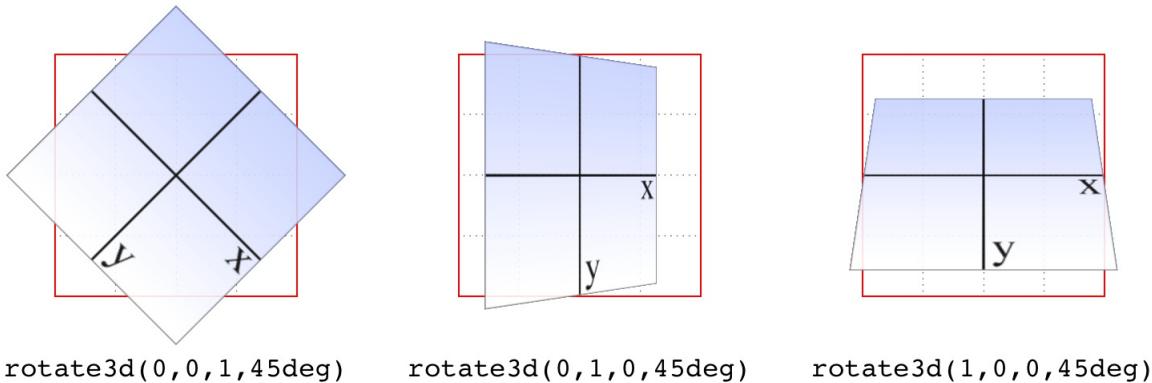
Function	Permitted value
----------	-----------------

`rotate3d() <number>, <number>, <number>, <angle>`

If you're comfortable with vectors and want to rotate an element through 3D space, then `rotate3d()` is for you. The first three numbers specify the x, y, and z components of a vector in 3D space, and the degree value (angle) determines the amount of rotation around the declared 3D vector.

To start with a simple example, the 3D equivalent to `rotate(45deg)` is

`rotate3d(0,0,1,45deg)`. This specifies a vector of zero magnitude on the x- and y-axes, and a magnitude of 1 along the z-axis. In other words, it describes the z-axis. The element is thus rotated 45 degrees around that vector, as shown in [Figure 1-13](#). This figure also shows the appropriate `rotate3d()` values to rotate an element by 45 degrees around the x- and y-axes.



**Figure 8-13. Rotations around 3D vectors**

A little more complicated is something like `rotate3d(-0.95,0.5,1,45deg)`, where the described vector points off into 3D space between the axes. In order to understand how this works, let's start with a simple example:

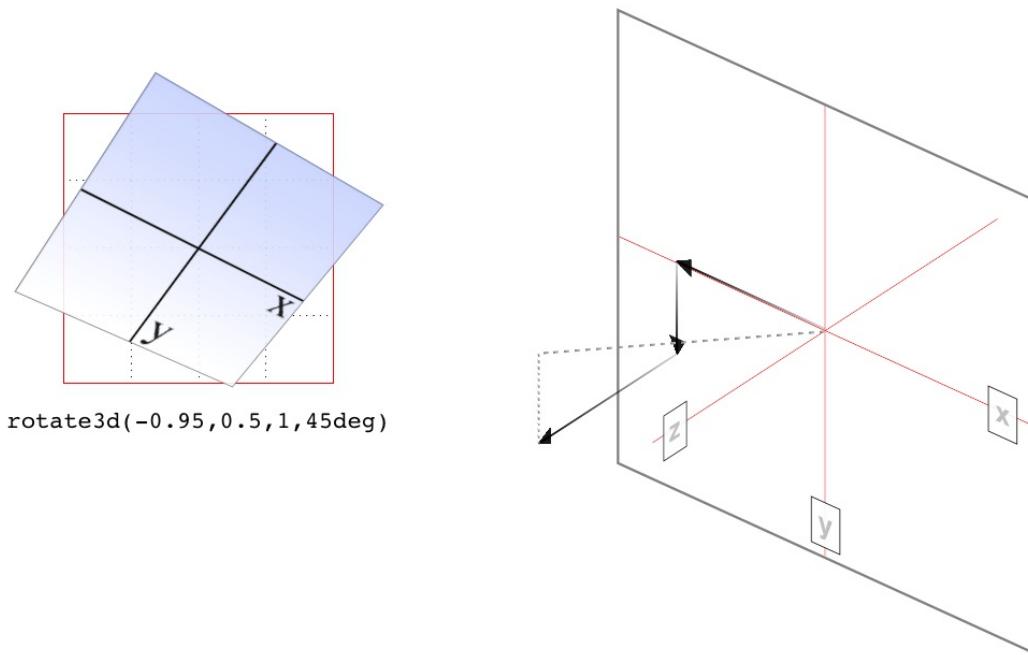
`rotateZ(45deg)` (illustrated in [Figure 1-13](#)). The equivalent is `rotate3d(0,0,1,45deg)`. The first three numbers describe the components of a vector that has no x or y magnitude, and a z magnitude of 1. Thus, it points along the z-axis in a positive direction; that is, toward the viewer. The element is then rotated clockwise as you look toward the origin of the vector. Simple enough.

Similarly, the 3D equivalent of `rotateX(45deg)` is `rotate3d(1,0,0,45deg)`. The vector points along the x-axis in the positive direction (to the right). If you stand at the end of that vector and look toward its origin, then you rotate the element 45 degrees clockwise around the vector. Thus, from the usual viewer placement, the top of the element rotates away from and the bottom rotates toward the viewer.

Let's make it slightly more complex: suppose you have `rotate3d(1,1,0,45deg)`. When viewed on your monitor, that describes a vector running from the top-left to bottom-right corner, going right through

the center of the element (by default, anyway; we'll see how to change that later on). So the element's rectangle has a line running through it at a 45-degree angle, effectively spearing it. Then the vector rotates 45 degrees, taking the element with it. The rotation is clockwise as you look back toward the vector's origin, so again, the top of the element rotates away from the viewer, while the bottom rotates toward the viewer. If we were to change the rotation to `rotate3d(1,1,0,90deg)`, then the element would be edge-on to the viewer, tilted at a 45-degree angle and facing off toward the upper right. Try it with a piece of paper: draw a line from the top left to bottom right, and then rotate the paper around that line.

Okay, so given all that, try visualizing how the vector is determined for `rotate3d(-0.95,0.5,1,45deg)`. If we assume a cube 200 pixels on a side, the vector's components are 190 pixels to the *left* along the x-axis, 100 pixels down along the y-axis, and 200 pixels toward the viewer along the z-axis. The vector goes from the origin point (0, 0, 0) to the point (-190px, 100px, 200px). [Figure 1-14](#) depicts that vector, as well as the final result presented to the viewer.

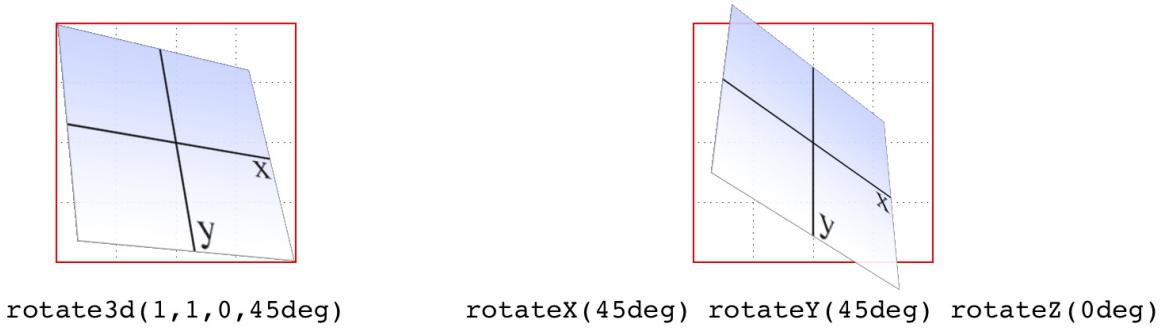


**Figure 8-14.** Rotation around a 3D vector, and how that vector is determined

So the vector is like a metal rod speared through the element being rotated. As we look back along the line of the vector, the rotation is 45 degrees clockwise. But since the vector points left, down, and forward, that means the top left corner of the element rotates toward the viewer, and the bottom right rotates away, as shown in [Figure 1-14](#).

Just to be crystal clear, `rotate3d(1, 1, 0, 45deg)` is *not* equivalent to `rotateX(45deg) rotateY(45deg) rotateZ(0deg)`! It's an easy mistake to make, and many people—including several online tutorial authors and, until researching and writing this section, your humble correspondent—have made it. It seems like it should be equivalent, but it really isn't. If we place that vector inside the imaginary  $200 \times 200 \times 200$  cube previously mentioned, the axis of rotation would go from the origin point to a point 200 pixels right and 200 pixels down (200, 200, 0).

Having done that, the axis of rotation is shooting through the element from the top left to the bottom right, at a 45-degree angle. The element then rotates 45 degrees clockwise around that diagonal, as you look back toward its origin (the top left), which rotates the top-right corner of the element away and a bit to the left, while the bottom-left corner rotates closer and a bit to the right. This is distinctly different than the result of `rotateX(45deg) rotateY(45deg) rotateZ(0deg)`, as you can see in [Figure 1-15](#).



**Figure 8-15.** The difference between rotating around two axes and rotating around a 3D axis

## Skew functions

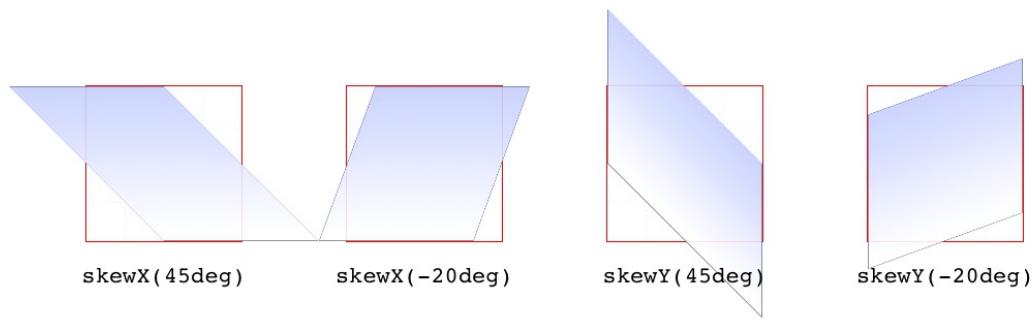
When you skew an element, you slant it along one or both of the x- and y-

axes. There is no z-axis or other 3D skewing.

<b>Functions</b>	<b>Permitted value</b>
------------------	------------------------

`skewX()`, `skewY()` <angle>

In both cases, you supply an angle value, and the element is skewed to match that angle. It's much easier to show skewing rather than try to explain it in words, so [Figure 1-16](#) shows a number of skew examples along the x- and y-axes.

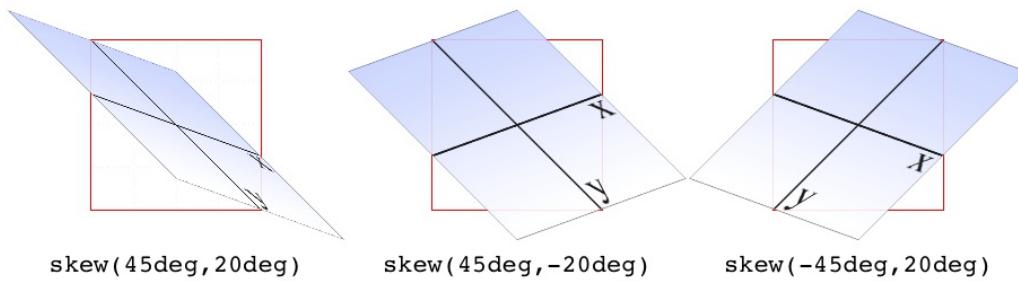


**Figure 8-16.** Skewing along the x- and y-axes

<b>Function</b>	<b>Permitted values</b>
-----------------	-------------------------

`skew()`    <angle> [, <angle> ] ?

The behavior of including `skew(a,b)` is different from including `skewX(a)` with `skewY(b)`. Instead, it specifies a 2D skew using the matrix operation `[ax,ay]`. [Figure 1-17](#) shows some examples of this matrix skewing and how they differ from double-skew transforms that look the same at first, but aren't.



**Figure 8-17. Skewed elements**

If you supply two values, the x skew angle is always first, and the y skew angle comes second. If you leave out a y skew angle, then it's treated as zero.

## The perspective function

If you're transforming an element in 3D space, you most likely want it to have some perspective. Perspective gives the appearance of front-to-back depth, and you can vary the amount of perspective applied to an element.

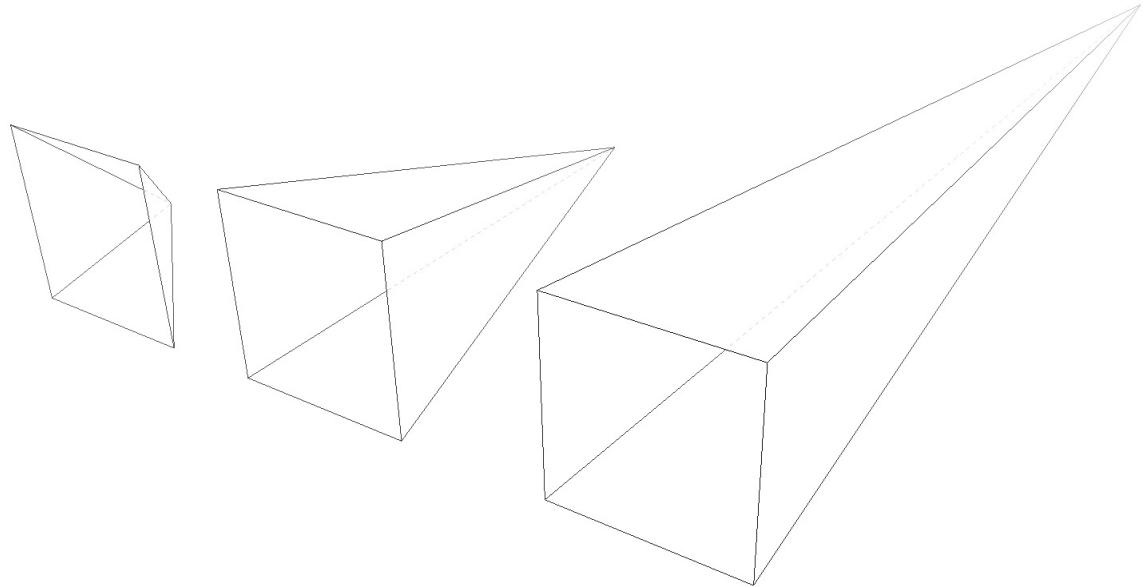
Function	Permitted values
<code>perspective()</code>	<code>&lt;length&gt;</code>

`perspective() <length>`

It might seem a bit weird that you specify perspective as a distance. After all, `perspective(200px)` seems a bit odd when you can't really measure pixels along the z-axis. And yet, here we are. You supply a length, and the illusion of depth is constructed around that value. Lower numbers create more extreme perspective, as though you are right up close to the element and viewing it through a fish-eye lens. Higher numbers create a gentler perspective, as though viewing the element through a zoom lens from far away. *Really* high perspective values create an isometric effect.

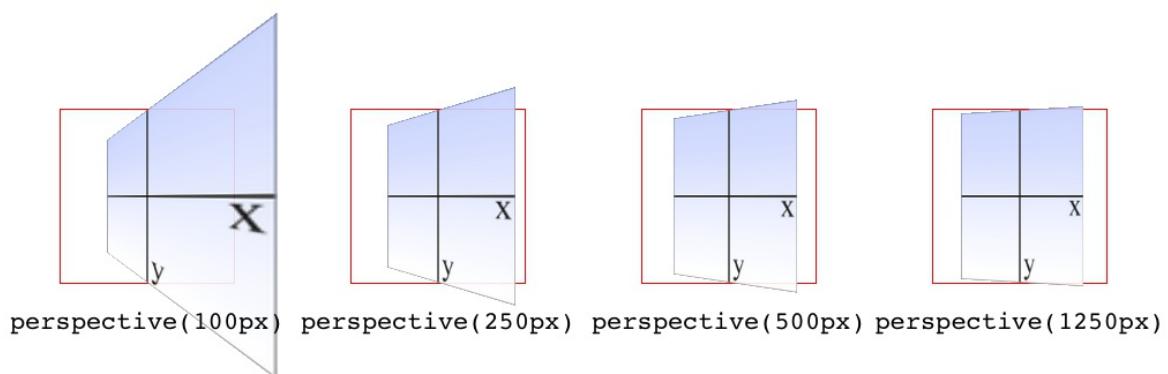
This makes a certain amount of sense. If you visualize perspective as a pyramid, with its apex point at the perspective origin and its base the closest thing to you, then a shorter distance between apex and base will create a

shallower pyramid, and thus a more extreme distortion. This is illustrated in [Figure 1-18](#), with hypothetical pyramids representing 200 px, 800 px, and 2,000 px perspective distances.



**Figure 8-18. Different perspective pyramids**

In the documentation for Safari, Apple writes that perspective values below 300px tend to be extremely distorted, values above 2000px create “very mild” distortion, and values between 500px and 1000px create “moderate perspective.”<sup>1</sup> To illustrate this, [Figure 1-19](#) shows a series of elements with the exact same rotation as displayed with varying perspective values.



**Figure 8-19.** The effects of varying perspective values

Perspective values must always be positive, nonzero lengths. Any other value will cause the `perspective()` function to be ignored. Also note that its placement in the list of functions is very important. If you look at the code for [Figure 1-19](#), the `perspective()` function comes before the `rotateY()` function. If you were to reverse the order, the rotation would happen before the perspective is applied, so all four examples in [Figure 1-19](#) would look exactly the same. So if you plan to apply a perspective value via the list of transform functions, make sure it comes first, or at the very least before any transforms that depend on it. This serves as a particularly stark reminder that the order in which you write `transform` functions can be very important.

**Note**

Note that the function `perspective()` is very similar to the property `perspective`, which will be covered later, but they are applied in critically different ways. Generally, you will want to use the `perspective` property instead of the `perspective()` function, but there may be exceptions.

## Matrix functions

If you’re a particular fan of advanced math, or stale jokes derived from Wachowski Brothers movies, then these functions will be your favorites.

Function	Permitted values
----------	------------------

`matrix() <number> [, <number> ] {5, 5}`

In the CSS transforms specification, we find the trenchant description of `matrix()` as a function that “specifies a 2D transformation in the form of a transformation matrix of the six values *a-f*.”

First things first: a valid `matrix()` value is a list of six comma-separated numbers. No more, no less. The values can be positive or negative. Second,

the value describes the final transformed state of the element, combining all of the other transform types (rotation, skewing, and so on) into a very compact syntax. Third, very few people actually use this syntax.

We're not actually going to go through the complicated process of actually doing the matrix math. For most readers, it would be an eye-watering wall of apparent gibberish; and for the rest, it would be time wasted on familiar territory. You can certainly research the intricacies of matrix calculations online, and I encourage anyone with an interest to do so. We'll just look at the basics of syntax and usage in CSS.

Here's a brief rundown of how it works. Say you have this function applied to an element:

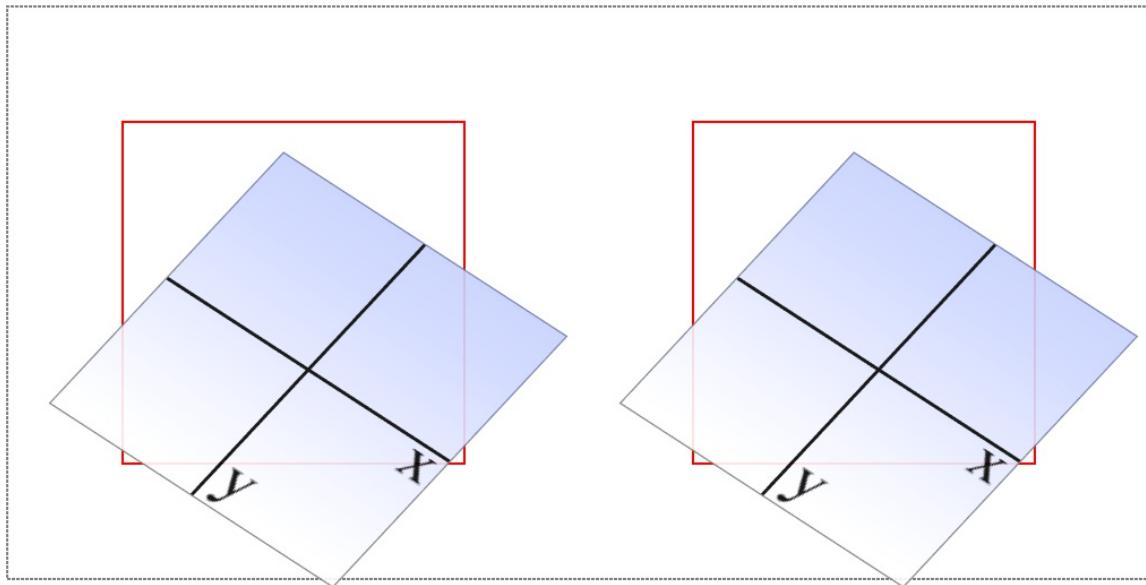
```
matrix(0.838671, 0.544639, -0.692519, 0.742636, 6.51212, 34.0381)
```

That's the CSS syntax used to describe this transformation matrix:

0.838671	-0.692519	0	6.51212
0.544639	0.742636	0	34.0381
0	0	1	0
0	0	0	1

Right. So what does that do? It has the result shown in [Figure 1-20](#), which is exactly the same result as writing this:

```
rotate(33deg) translate(24px, 25px) skewX(-10deg)
```



**Figure 8-20.** A matrix-transformed element and its functional equivalent

What this comes down to is that if you’re familiar with or need to make use of matrix calculations, you can and should absolutely use them. If not, you can chain much more human-readable transform functions together and get the element to the same end state.

Now, that was for plain old 2D transforms. What if you want to use a matrix to transform through three dimensions?

<b>Function</b>	<b>Permitted values</b>
-----------------	-------------------------

```
matrix3d() <number> [, <number> ] {15,15}
```

Again, just for kicks, we’ll savor the definition of `matrix3d()` from the CSS Transforms specification: “specifies a 3D transformation as a  $4 \times 4$  homogeneous matrix of 16 values in column-major order.” This means the value of `matrix3d` *must* be a list of 16 comma-separated numbers, no more or less. Those numbers are arranged in a  $4 \times 4$  grid in column order, so the first column of the matrix is formed by the first set of four numbers in the value, the second column by the second set of four numbers, the third column by the third set, and so on. Thus, you can take the following function:

```
matrix3d(
  0.838671, 0, -0.544639, 0.00108928,
  -0.14788, 1, 0.0960346, -0.000192069,
  0.544639, 0, 0.838671, -0.00167734,
  20.1281, 25, -13.0713, 1.02614)
```

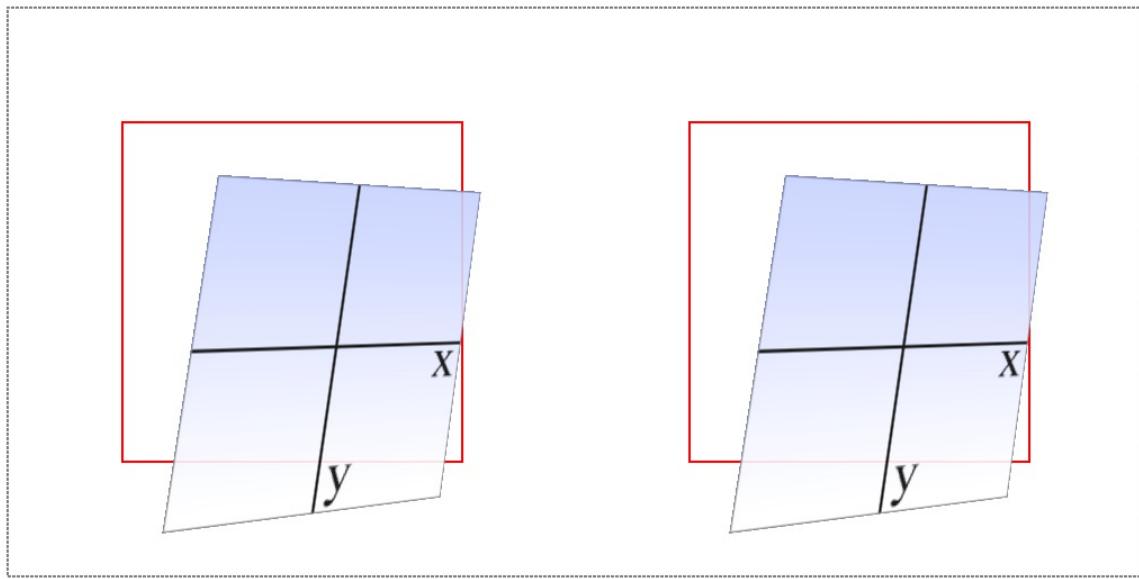
And write it out as this matrix:

0.838671	-0.14788	0.544639	20.1281
0	1	0	25
-0.544639	0.0960346	0.838671	-13.0713
0.00108928	-0.000192069	-0.00167734	1.02614

Both of which have an end state equivalent to:

`perspective(500px) rotateY(33deg) translate(24px, 25px) skewX(-10d`

as shown in [Figure 1-21](#).



**Figure 8-21.** A matrix3d-transformed element and its functional equivalent

## A note on end-state equivalence

It's important to keep in mind that only the end states of a `matrix()` function, and of an equivalent chain of transform functions, can be considered

identical. This is for the same reason discussed in the section on rotation: because a rotation angle of  $393\text{deg}$  will end with the same visible rotation as an angle of  $33\text{deg}$ . This matters if you are animating the transformation, since the former will cause the element to do a barrel roll in the animation, whereas the latter will not. The `matrix()` version of this end state won't include the barrel roll, either. Instead, it will always use the shortest possible rotation to reach the end state.

To illustrate what this means, consider the following: a transform chain and its `matrix()` equivalent:

```
rotate(200deg) translate(24px, 25px) skewX(-10deg)  
matrix(-0.939693, -0.34202, 0.507713, -0.879385, -14.0021, -31.70
```

Note the rotation of 200 degrees. We naturally interpret this to mean a clockwise rotation of 200 degrees, which it does. If these two transforms are animated, however, they will have act differently: the chained-functions version will indeed rotate 200 degrees clockwise, whereas the `matrix()` version will rotate 160 degrees counterclockwise. Both will end up in the same place, but will get there in different ways.

There are similar differences that arise even when you might think they wouldn't. Once again, this is because a `matrix()` transformation will always take the shortest possible route to the end state, whereas a transform chain might not. (In fact, it probably doesn't.) Consider these apparently equivalent transforms:

```
rotate(160deg) translate(24px, 25px) rotate(-30deg) translate(-100  
matrix(-0.642788, 0.766044, -0.766044, -0.642788, 33.1756, -91.88
```

As ever, they end up in the same place. When animated, though, the elements will take different paths to reach that end state. They might not be obviously different at first glance, but the difference is still there.

Of course, none of this matters if you aren't animating the transformation, but it's an important distinction to make nevertheless, because you never know when you'll decide to start animating things. (Hopefully after reading the companion text on animations!)

# More Transform Properties

In addition to the base `transform` property, there are a few related properties that help to define things such as the origin point of a transform, the perspective used for a “scene,” and more.

# Moving the Origin

So far, all of the transforms we've seen have shared one thing in common: the precise center of the element was used as the *transform origin*. For example, when rotating the element, it rotated around its center, instead of, say, a corner. This is the default behavior, but with the property `transform-origin`, you can change it.

## `transform-origin`

**Values:** [ left | center | right | top | bottom |  
<percentage> | <length> ] | [ left | center | right  
| <percentage> | <length> ] [ top | center | bottom  
| <percentage> | <length> ] <length>? |

**Initial value:** 50% 50%

**Applies to:** Any transformable element

**Inherited:** No

**Percentages:** Refer to the size of the bounding box (see explanation)

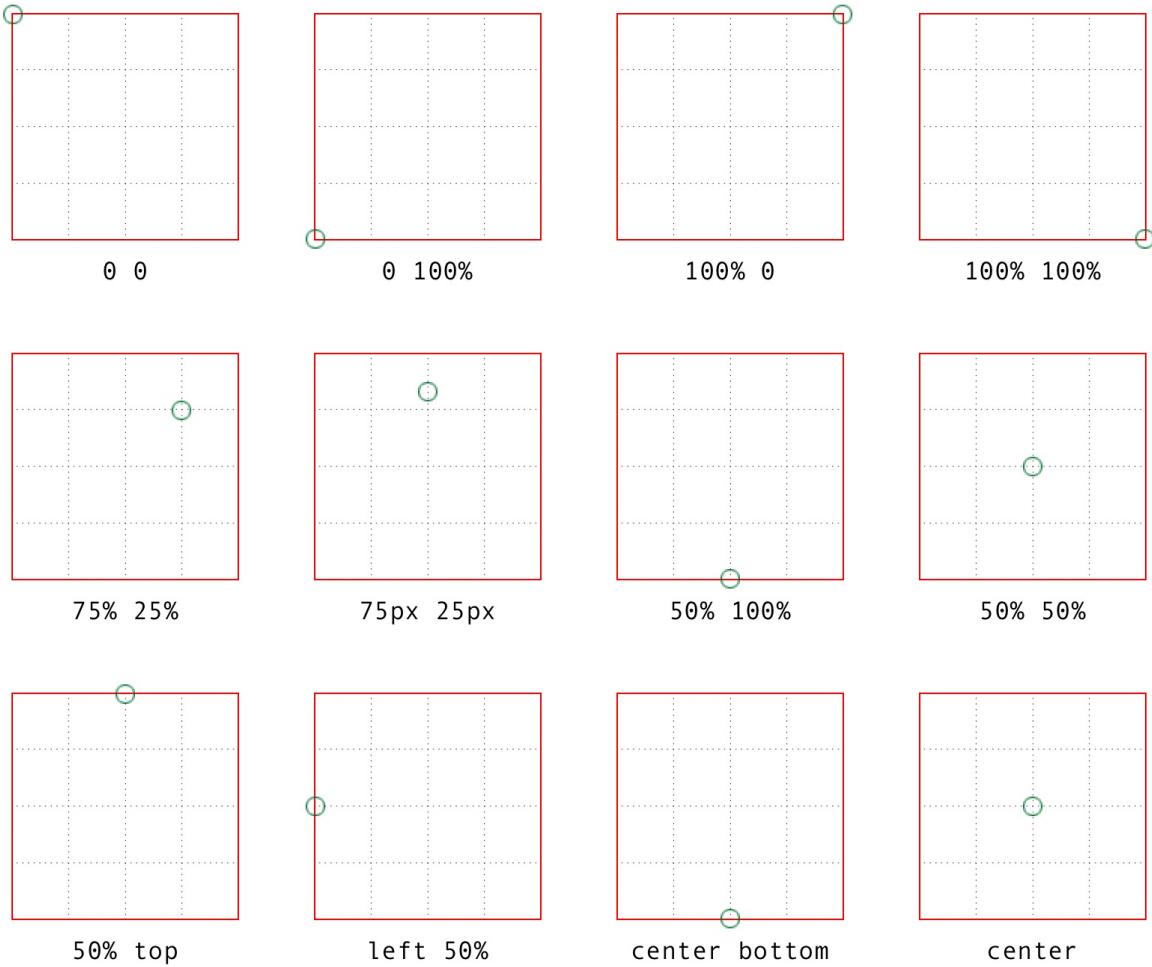
**Computed value:** A percentage, except for length values, which are converted to an absolute length

The syntax definition looks really abstruse and confusing, but it's actually very simple in practice. With `transform-origin`, you supply two or three

keywords to define the point around which transforms should be made: first the horizontal, then the vertical, and optionally a length along the z-axis. For the horizontal and vertical axes, you can use plain-English keywords like `top` and `right`, percentages, lengths, or a combination of different keyword types. For the z-axis, you can't use plain-English keywords or percentages, but can use any length value. Pixels are by far the most common.

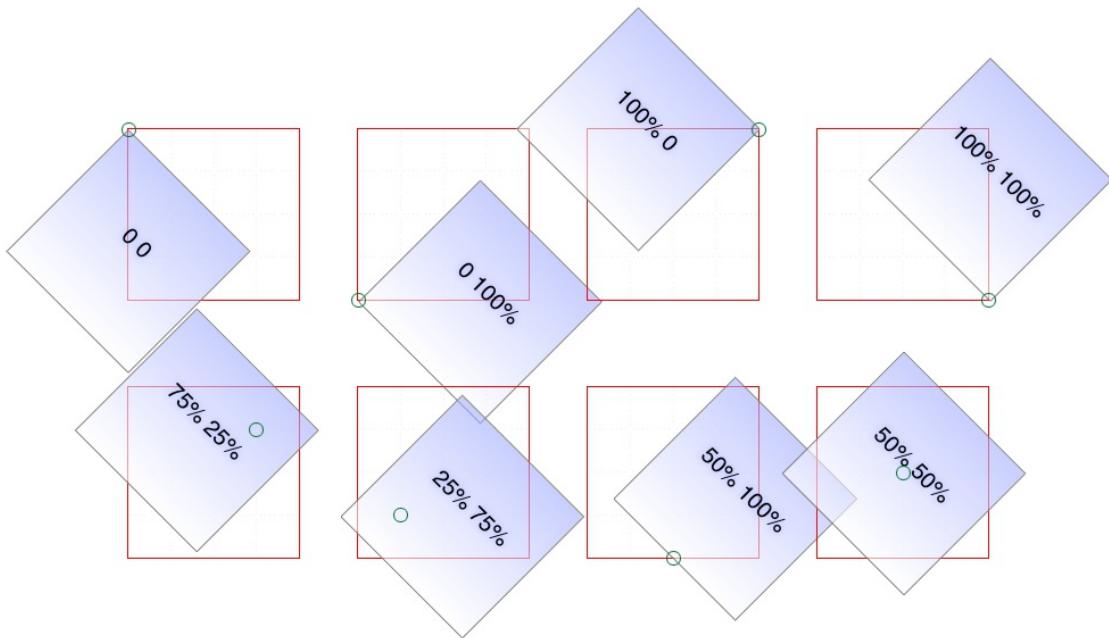
Length values are taken as a distance starting from the top-left corner of the element. Thus, `transform-origin: 5em 22px` will place the transform origin 5 em to the right of the left side of the element, and 22 pixels down from the top of the element. Similarly, `transform-origin: 5em 22px -200px` will place it 5 em over, 22 pixels down, and 200 pixels away; that is, 200 pixels behind the place where the element sits.

Percentages are calculated with respect to the corresponding axis and size of the element, as offsets from the element's top-left corner. For example, `transform-origin: 67% 40%` will place the transform origin 67 percent of the width to the right of the element's left side, and 40 percent of the element's height down from the element's top side. [Figure 1-22](#) illustrates a few origin calculations.



**Figure 8-22. Various origin calculations**

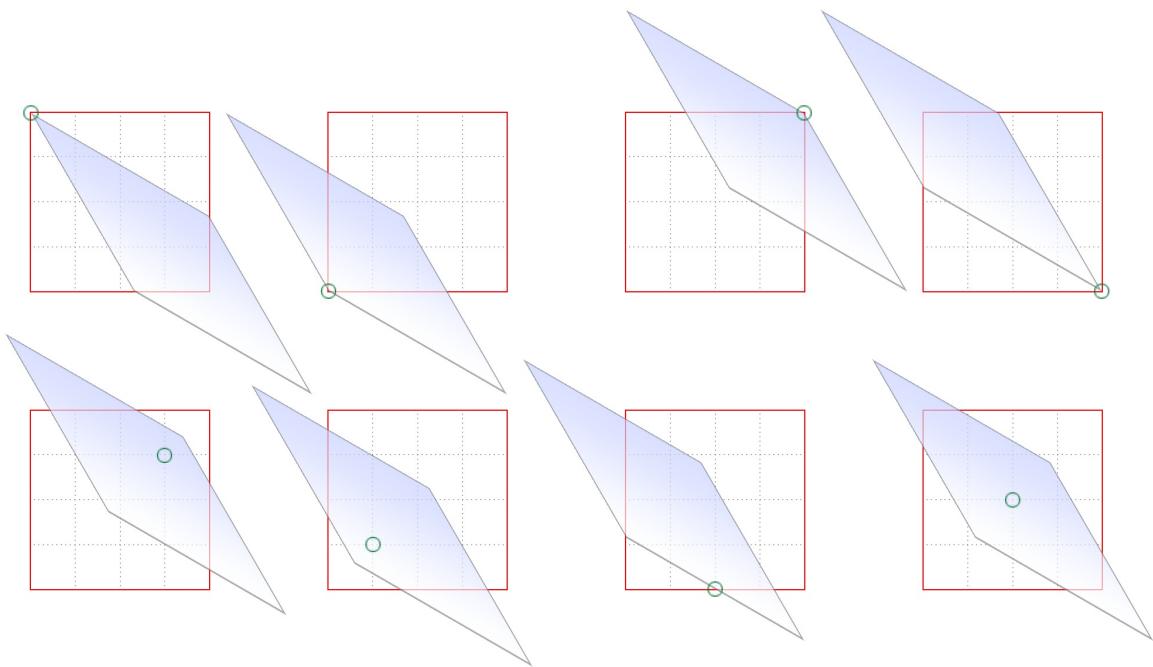
All right, so if you change the origin, what happens? The easiest way to visualize this is with 2D rotations. Suppose you rotate an element 45 degrees to the right. Its final placement will depend on its origin. [Figure 1-23](#) illustrates the effects of several different transform origins; in each case, the transform origin is marked with a circle.



**Figure 8-23.** The rotational effects of using various transform origins

The origin matters for other transform types, such as skews and scales. Scaling an element with its origin in the center will pull in all sides equally, whereas scaling an element with a bottom-right origin will cause it to shrink toward that corner. Similarly, skewing an element with respect to its center will result in the same shape as if it's skewed with respect to the top-right corner, but the placement of the shape will be different. Some examples are shown in [Figure 1-24](#); again, each transform origin is marked with a circle.

The one transform type that isn't really affected by changing the transform origin is translation. If you push an element around with `translate()`, or its cousins like `translateX()` and `translateY()`, it's going to end up in the same place regardless of where the transform origin is located. If that's all the transforming you plan to do, then setting the transform origin is irrelevant. If you ever do anything besides translating, though, the origin will matter. Use it wisely.



**Figure 8-24.** The skew effects of using various transform origins

# Choosing a 3D Style

If you’re setting elements to be transformed through three dimensions—using, say, `translate3d()` or `rotateY()`—you probably expect that the elements will be presented as though they’re in a 3D space. And yet, this is not the default behavior. By default, everything looks flat no matter what you do. Fortunately, this can be overridden with the `transform-style` property.

## **transform-style**

**Values:** `flat` | `preserve-3d`

**Initial value:** `flat`

**Applies to:** Any transformable element

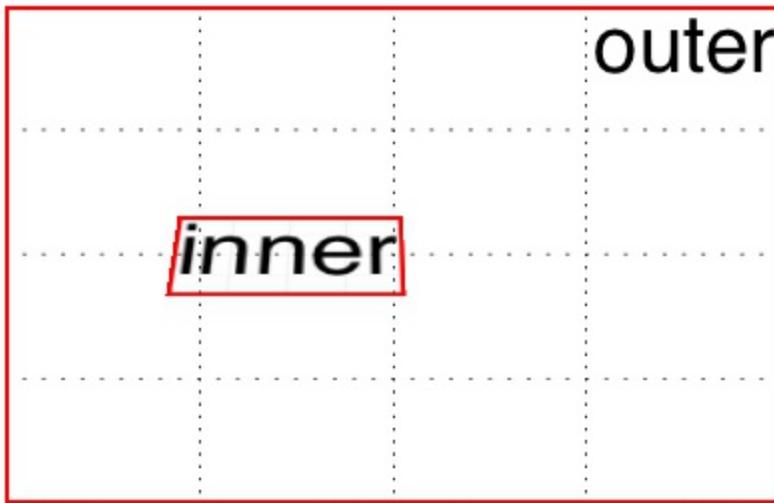
**Inherited:** No

**Computed value:** As specified

Suppose you have an element you want to move “closer to” your eye, and then tilt away a bit, with a moderate amount of perspective. Something like this rule, as applied to the following HTML:

```
div#inner {transform: perspective(750px) translateZ(60px) rotateX  
<div id="outer">  
outer  
<div id="inner">inner</div>  
</div>
```

So you do that, and get the result shown in [Figure 1-25](#); more or less what you might have expected.

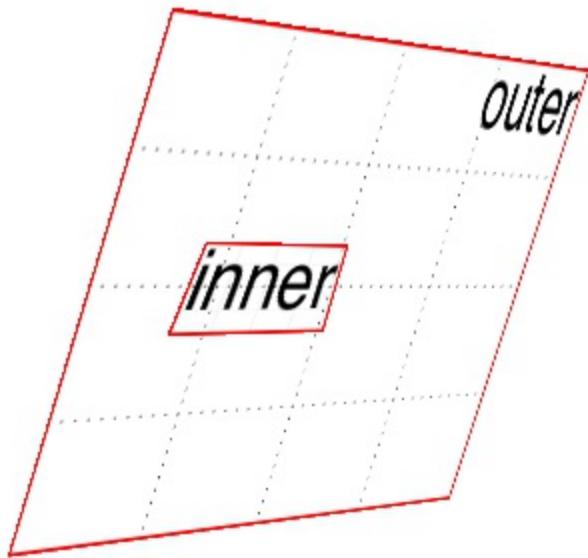


**Figure 8-25.** A 3D-transformed inner div

But then you decide to rotate the outer `div` to one side, and suddenly nothing makes sense any more. The inner `div` isn't where you envisioned it. In fact, it just looks like a picture pasted to the front of the outer `div`.

Well, that's exactly what it is, because the default value of `transform-style` is `flat`. The inner `div` got drawn in its moved-forward-tilted-back state, and that was applied to the front of the outer `div` as if it was an image. So when you rotated the outer `div`, the flat picture rotated right along with it, as shown in [Figure 1-26](#):

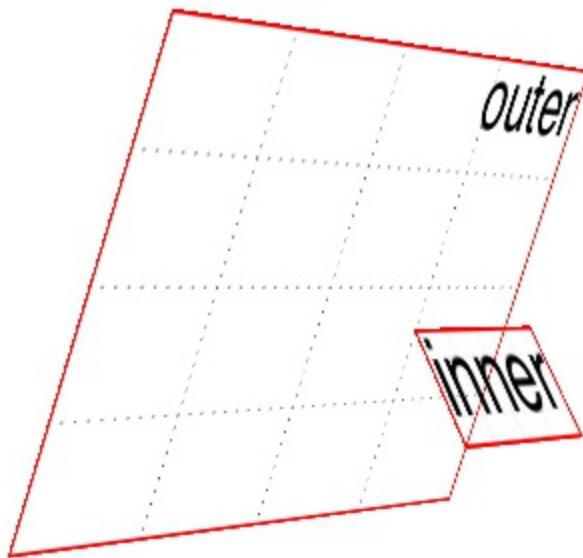
```
div#outer {transform: perspective(750px) rotateY(60deg) rotateX(-30deg);}  
div#inner {transform: perspective(750px) translateZ(60px) rotateX(-30deg);}
```



**Figure 8-26.** The effects of a flat transform style

Change the value to `preserve-3d`, however, and things are suddenly different. The `inner` `div` will be drawn as a full 3D object with respect to its parent `outer` `div`, floating in space nearby, and *not* as a picture pasted on the front of the `outer` `div`. You can see the results of this change in [Figure 1-27](#):

```
div#outer {transform: perspective(750px) rotateY(60deg) rotateX(-  
    transform-style: preserve-3d; }  
div#inner {transform: perspective(750px) translateZ(60px) rotateX
```



**Figure 8-27. The effects of a 3D-preserved transform style**

One important aspect of `transform-style` is that it can be overridden by other properties. The reason is that some values of these other properties require a flattened presentation of an element and its children in order to work at all. In such cases, the value of `transform-style` is forced to be `flat`, regardless of what you may have declared.

So, in order to avoid this overriding behavior, make sure the following properties are set to the listed values:

- `overflow: visible`
- `filter: none`
- `clip: auto`
- `clip-path: none`
- `mask-image: none`
- `mask-border-source: none`
- `mix-blend-mode: normal`

Those are all the default values for those properties, so as long as you don't try to change any of them for your preserved 3D elements, you're fine! But if you find that editing some CSS suddenly flattens out your lovely 3D transforms, one of these properties might be the culprit.

One more note: in addition to the values just mentioned, the value of the property `isolation` must be, or be computed to be, `isolate`. (`isolation` is a compositing property, in case you were wondering.)

# Changing Perspective

There are actually two properties that are used to define how perspective is handled: one to define the perspective distance, as with the `perspective()` function discussed in an earlier section; and another to define the perspective's origin point.

## Defining a group perspective

First, let's consider the property `perspective`, which accepts a length that defines the depth of the perspective pyramid. At first glance, it looks just like the `perspective()` function discussed earlier, but there are some very critical differences.

### `perspective`

**Values:**      `none` | `<length>`

**Initial value:**    `flat`

**Applies to:**     Any transformable element

**Inherited:**      No

**Computed value:** The absolute length, or else `none`

As a quick example, if you want to create a very deep perspective, one mimicking the results you'd get from a zoom lens, you might declare something like `perspective: 2500px`. For a shallow depth, one that mimics

a closeup fish-eye lens effect, you might declare `perspective: 200px`.

So how does this differ from the `perspective()` function? When you use `perspective()`, you're defining the perspective effect for the element that is given that function. So if you say `transform: perspective(800px) rotateY(-50grad);`, you're applying that perspective to each element that has the rule applied.

With the `perspective` property, on the other hand, you're creating a perspective depth that is applied to all the child elements of the element that received the property. Confused yet? Don't be. Here's a simple illustration of the difference, as shown in [Figure 1-28](#):

```
div {transform-style: preserve-3d; border: 1px solid gray; width: 100px; height: 100px; margin: 10px; position: relative; overflow: hidden; background-color: #f0f0f0;}
```

```
#one {perspective: none;}
```

```
#one img {transform: perspective(800px) rotateX(-50grad);}
```

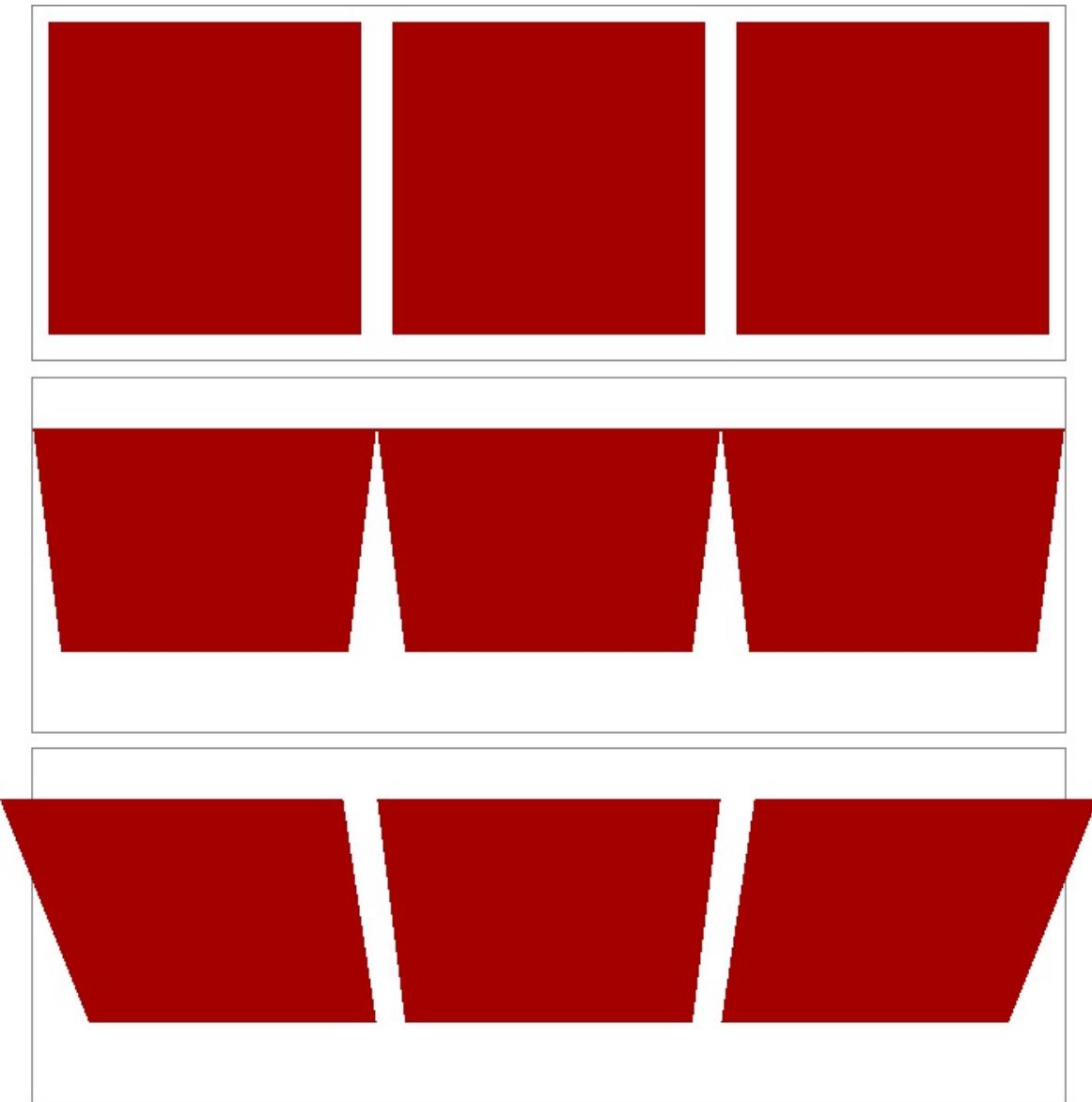
```
#two {perspective: 800px;}
```

```
#two img {transform: rotateX(-50grad);}
```

```
<div></div>
```

```
<div id="one"></div>
```

```
<div id="two"></div>
```



**Figure 8-28. Shared perspective versus individual perspectives**

In [Figure 1-28](#), we first see a line of images that haven't been transformed. In the second line, each image has been rotated 50 gradians (equivalent to 45 degrees) toward us, but each one within its own individual perspective.

In the third line of images, none of them has an individual perspective. Instead, they are all drawn within the perspective defined by `perspective: 800px;` that's been set on the `div` that contains them. Since they all operate within a shared perspective, they look "correct"; that is, like we would expect if we had three physical pictures mounted on a clear sheet of glass and

rotated toward us around the center horizontal axis of that glass.

**Note**

Note that presence of `transform-style: preserve-3d` makes this effect possible, as discussed in the previous section.

This is the critical difference between `perspective`, the property; and `perspective()`, the function. The former creates a 3D space shared by all its children. The latter affects only the element to which it's applied. A less important difference is that the `perspective()` function has to come first or early in its chain of transforms in order to apply to the element as it's transformed through 3D space. The `perspective` property, on the other hand, is applied to all children regardless of where their transforms are declared.

In most cases, you're going to use the `perspective` property instead of the `perspective()` function. In fact, container `divs` (or other elements) are a very common feature of 3D transforms—the way they used to be for page layout—largely to establish a shared perspective. In the previous example, the `<div id="two">` was there solely to serve as a perspective container, so to speak. On the other hand, we couldn't have done what we did without it.

## Moving the perspective's origin

When transforming elements in three dimensions—assuming you've allowed them to appear three-dimensional, that is—a `perspective` will be used. (See `transform-style` and `perspective`, respectively, in previous sections.) That `perspective` will have an origin, which is also known as the *vanishing point*, and you can change where it's located with the property `perspective-origin`.

### `perspective-origin`

**Values:** [ left | center | right | top | bottom |  
<percentage> | <length> ] | [ left | center | right  
| <percentage> | <length> ] [ top | center | bottom

```
| <percentage> | <length> ] <length>? | [ center | [  
left | right ] ] && [ center | [ top | bottom ] ]
```

**Initial value:** 50% 50%

**Applies to:** Any transformable element

**Inherited:** No

**Percentages:** Refer to the size of the bounding box (see explanation)

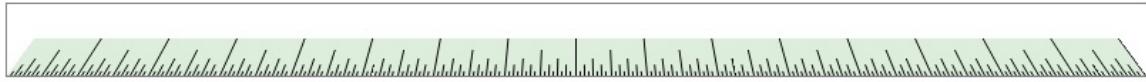
**Computed value:** A percentage, except for length values, which are converted to an absolute length

As you've no doubt spotted, `perspective-origin` and `transform-origin` (discussed earlier) have the same value syntax, right down to allowing an optional length value defining an offset along the z-axis. While the way the values are expressed is identical, the effects they have are very different. With `transform-origin`, you define the point around which transforms happen. With `perspective-origin`, you define the point on which sight lines converge.

As with most 3D transform properties, this is more easily demonstrated than described. Consider the following CSS and markup, illustrated in [Figure 1-29](#):

```
#container {perspective: 850px; perspective-origin: 50% 0%;}  
#ruler {height: 50px; background: #DED url(tick.gif) repeat-x;  
        transform: rotateX(60deg);  
        transform-origin: 50% 100%;}  
  
<div id="container">  
  <div id="ruler"></div>
```

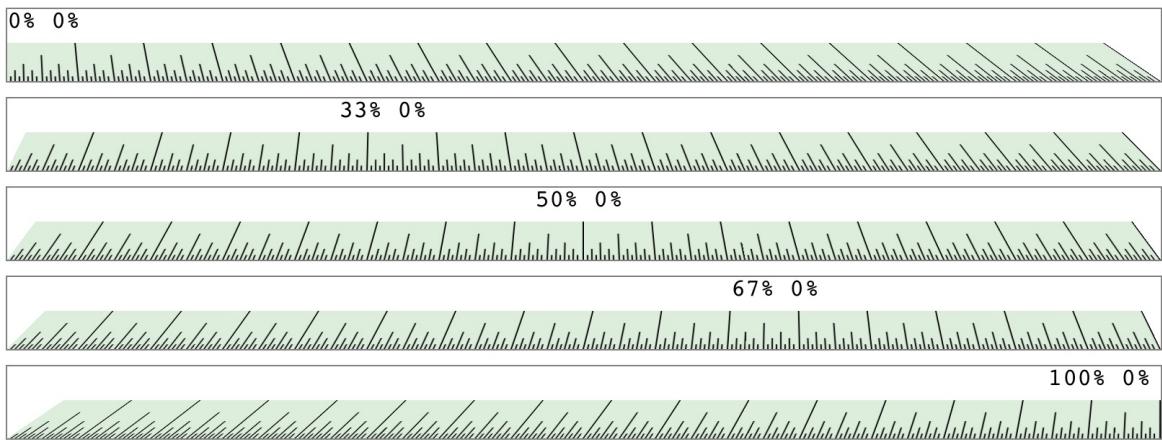
```
</div>
```



**Figure 8-29.** A basic “ruler”

What we have is a repeated background image of tick-marks on a ruler, with the `div` that contains them tiled away from us by 60 degrees. All the lines point at a common vanishing point, the top center of the container `div` (because of the `50% 0%` value for `perspective-origin`).

Now consider that same setup with various perspective origins, as shown in [Figure 1-30](#).



**Figure 8-30.** A basic “ruler” with different perspective origins

As you can see, moving the perspective origin changes the rendering of the 3D-transformed element.

Note that these only had an effect because we supplied a value for `perspective`. If the value of `perspective` is ever the default `none`, then any value given for `perspective-origin` will be ignored. That makes sense, since you can't have a perspective origin when there's no perspective at all!

# Dealing with Backfaces

Something you probably never really thought about, over all the years you've been laying out elements, was: what would it look like if I could see the back side of the element? Now that 3D transforms are a possibility, there may well come a day when you *do* see the back side of an element. You might even mean to do so intentionally. What happens at that moment is determined by the property `backface-visibility`.

## **backface-visibility**

**Values:** `visible` | `hidden`

**Initial value:** `visible`

**Applies to:** Any transformable element

**Inherited:** No

**Computed value:** As specified

Unlike many of the other properties and functions we've already talked about, this one is as straightforward as straightforward can be. All it does is determine whether the back side of an element is rendered when it's facing toward the viewer, or not. It really is just that simple.

So let's say you flip over two elements, one with `backface-visibility` set to the default value of `visible` and the other set to `hidden`. You get the result shown in [Figure 1-31](#):

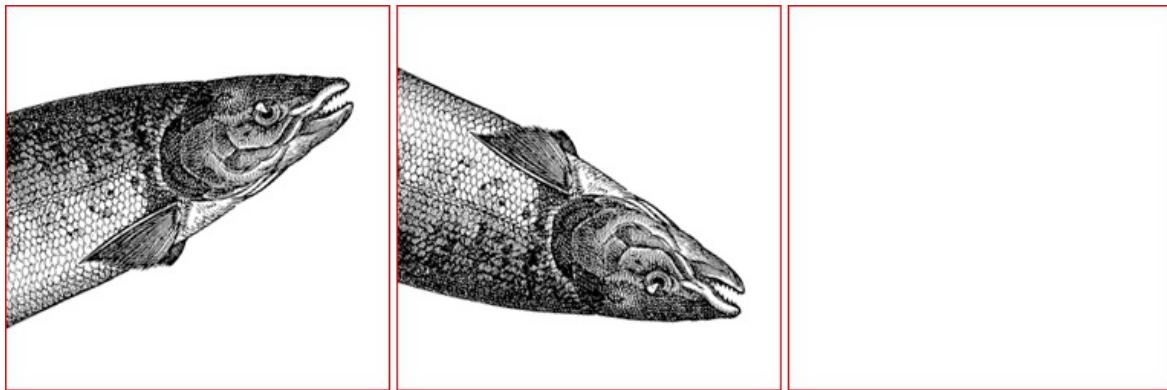
```

span {border: 1px solid red; display: inline-block;}
img {vertical-align: bottom;}
img.flip {transform: rotateX(180deg); display: inline-block;}
img#show {backface-visibility: visible;}
img#hide {backface-visibility: hidden;}





```



**Figure 8-31. Visible and hidden backfaces**

As you can see, the first image is unchanged. The second is flipped over around its x-axis, so we see it from the back. The third has also been flipped, but we can't see it at all because its backface has been hidden.

This property can come in handy in a number of situations. The simplest is a case where you have two elements that represent the two sides of a UI element that flips over; say, a search area with preference settings on its back, or a photo with some information on the back. Let's take the latter case. The CSS and markup might look something like this:

```

section {position: relative;}
img, div {position: absolute; top: 0; left: 0; backface-visibility: hidden;}
div {transform: rotateY(180deg);}
section:hover {transform: rotateY(180deg); transform-style: preserve-3d}

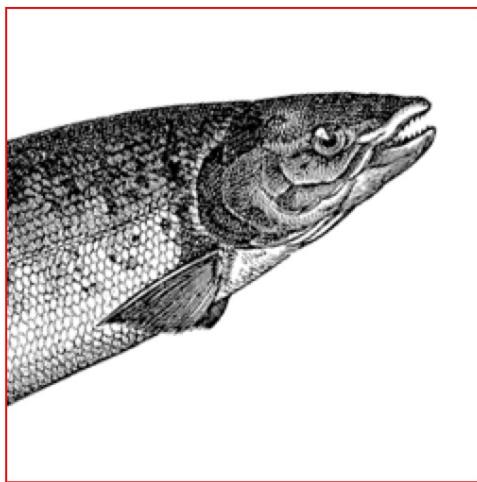
<section>
  
  <div class="info">(...info goes here...)</div>
</section>

```

Actually, this example shows that using `backface-visibility` isn't quite as simple as it first appears. It's not that the property itself is complicated, but if you forget to set `transform-style` to `preserve-3d`, then it won't work as intended. That's why `transform-style` is set on the `section` element.

There's a variant of this example that uses the same markup, but a slightly different CSS to show the image's backface when it's flipped over. This is probably more what was intended, since it makes information look like it's literally written on the back of the image. It leads to the end result shown in [Figure 1-32](#):

```
section {position: relative;}  
img, div {position: absolute; top: 0; left: 0;}  
div {transform: rotateY(180deg); backface-visibility: hidden;  
     background: rgba(255,255,255,0.85);}  
section:hover {transform: rotateY(180deg); transform-style: prese
```



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*Visual Presentation for the Web*

Eric A. Meyer, Estelle Weyl  
O'Reilly Media, 2016

**Figure 8-32. Photo on the front, information on the back**

The only thing we had to do to make that happen was to just shift the `backface-visibility: hidden` to the `div` instead of applying it to both the `img` and the `div`. Thus, the `div`'s backface is hidden when it's flipped over, but that of the image is not.

# Summary

With the ability to transform elements in two- and three-dimensional space, CSS transforms provide a great deal of power to designers who are looking for new ways to present information. From creating interesting combinations of 2D transforms, to creating a fully 3D-acting interface, transforms open up a great deal of new territory in the design space. There are some interesting dependencies between properties, which is something that not every CSS author will find natural at first, but they become second nature with just a bit of practice.

<sup>1</sup> <http://bit.ly/safari-2d-3d-transforms>

# Chapter 9. CSS Transitions and Animations

CSS transforms, CSS transitions, and CSS animations are three separate CSS specifications. While the three terms sound like they may do the same thing—make something move—CSS transitions and animations make things move *over time*. Transitions and animations let you define the transition between two or more states of an element.

Transforms change an element's appearance through translation, rotation, scaling, and skewing, but do not have a time component. You can use the CSS `transform` property to change the location of an element's coordinate space of the CSS visual formatting model, but you need `transitions` or `animation` to make that change occur over time. The `transform` property is covered in [\*Transforms in CSS\*](#) (O'Reilly).

While animation is possible with JavaScript, understanding CSS3 transitions and animations will save you a lot of time and effort if you need to animate anything on the Web. Generally, it will also save your users' CPU and battery compared to JavaScript.

Used correctly, CSS animations and transitions can give your web applications life and depth. While this booklet focuses on *how* to transition and animate elements in your documents, understanding *when* to use animation can improve your user experience (UX) as well. By adding the dimension of time, animating can help your UX communicate on a different level.

# 12 Basic Principles of Animation

Well before the advent of the Web, animators at Disney came up with 12 principles for cartoon animation. Some of these principles are very relevant to CSS animation as well.

According to the “bible of animation”—*The Illusion of Life: Disney Animation* by Frank Thomas and Ollie Johnston—there are 12 basic principles for animation, including:

## Squash and stretch

Depending on what something is made of, objects deform under motion. *Squashing and stretching* gives the illusion of weight and volume to an object or character as it bounces or otherwise moves. For example, when a ball bounces, it’s squashed as it hits the ground and stretches as it heads upward.

## Anticipation

Users may not understand an animation unless there is a sequence of actions that leads clearly from one activity to the next. They must *anticipate* or expect a change before it actually occurs. In cartoons, it’s a movement preparing the viewer for a major action the character is about to perform, like a knee bending before a jump. On the Web, it could be a button depression before the start of the more extensive animation that starts when the button is selected.

Guide your users mentally to where they should focus before initiating the main effect, especially if the start of the animation is important.

## Staging

In a cartoon, *staging* is the presentation of an idea so it is unmistakably clear. On the Web, staging is directing the user’s attention to an action, such as a small jiggle of the call-to-action button. Staging helps guide

users through the story or idea being told: for example, through the steps of a check-out process.

### Straight ahead action and pose to pose

There are two main approaches to animation on the big screen. In the *straight ahead* action approach, the animator starts at the first drawing and works drawing to drawing to the end of a scene. In *pose to pose*, the animator draws the main points within an animation and creates (or has an assistant create) the points in between later. While seemingly only applicable to storyboarding, this principle is also related to drawing keyframes and how the animation fills in the space or time between them.

With CSS animations, when we animate image sprites to create motion, we are emulating the Straight Ahead approach. This is described when we cover the steps values of the `animation-timing-function` property (see "[The step timing functions](#)"). In most animation scenarios, we let the browser be our assistant, defining specific points, or poses, within the animation and allowing the browser to interpolate property values as it animates from pose to pose, or keyframe definition to keyframe definition.

### Follow-through and overlapping action

*Follow-through* is the inclusion of additional motion when the main animation concludes. For example, if a character is running and stops, her hair and clothes were likely bouncing and fall back into place after her legs and body cease moving, catching up to the main mass of the character. Nothing stops all at once.

*Overlapping action* is when some components are slightly delayed after other components change direction, like the way Wile E. Coyote's legs keep moving forward as he drops off a cliff. His ears take a moment to follow.

If your CSS animations ever become complex enough to require follow-through and overlapping action, timing will be critical to making your

effects work.

## Slow in and slow out

Just like cars don't start and end at full speed—rather, they accelerate from stopped to full speed and decelerate back to zero—slow ins and slow outs make animation more lifelike and soften the action. Only mechanical animations will proceed at a linear speed.

The *slow in and slow out* principle states that the beginning and end of an animation are more interesting than its middle; and therefore, unless it's mechanical, the animation should proceed fastest in the middle of the animation, with a slower start and slower end. With cartoon animation, the effect is created by having more cells at the ends and fewer in the middle of the action. With CSS, this effect is created by setting cubic Bézier timing functions to something other than `linear` (see "[The `transition-timing-function` Property](#)").

## Arcs

The *arcs* principle states that almost all actions follow an arc or slightly circular path. Think of your hand moving back and forth as you walk: your hand arcs back and forth rather than always staying at an equal distance from the ground.

Linear animations can be very mechanical. Arcs can be achieved with granular control within a keyframe animation. Because of this, CSS developers often use CSS animations instead of transitions; animations offer more granularity in creating an arced path, while CSS transitions only allow for moving between two states. However, with some cubic Bézier timing functions, creating an arc with CSS transitions is actually not only possible, but fairly simple.

## Secondary action

*Secondary actions* can enrich a main action by adding dimension, supplementing or reinforcing the main action and giving the scene more life. If you include secondary actions, the animations should work

together in support of one another.

For example, if your main animation drops a module onto a page, a secondary action might be the main call-to-action button within the module dropping into place, then finishing its action a little after the main module has finished animating in. A secondary action should reinforce the main action. It is OK to literally “think outside the box” and animate a child element differently from its parent.

## Timing

*Timing* is likely the most important of the principles in this list when it comes to animation. While in traditional animation it’s based on the number of frames, in CSS animation it has more to do with creating the appropriate amount of time to read the motion, but not so long as to make the site appear slow. Timing includes not just the duration of the animation (see “[The animation-duration Property](#)”), but also the delay (“[The animation-delay Property](#)”) and timing function (“[The animation-timing-function Property](#)”).

There are no right answers when it comes to timing. Expertise in timing comes with experience and experimentation, if it comes at all. I recommend using trial and error to refine the timing of your animation, then cut your times in half: while you may want your animation to progress slowly enough to grok the difference in times and discover what is the best combination of duration, delay, and progression, you don’t want your site to appear slow.

## Exaggeration

*Exaggeration* is the highlighting of movements beyond their natural state to call attention to what you want the user to focus on. A tiny bit of exaggeration can give added life to an animation and actually make it look more realistic. Use good taste and common sense: exaggeration is not extreme distortion, but rather a slight distortion that gives emphasis without being so exaggerated as to be visibly distorted for your visitors.

## Solid drawing

The *solid drawing* principle includes the principles of drawing or coding forms that convey the illusion of three dimensions, with weight and solid form. In CSS, this includes using box shadows, gradients, and transforms, giving your content the illusion of being three-dimensional. If you aren't doing 3D animation or spriting, this principle is only tangentially related to web animation, as on the Web, we're drawing with CSS in a two-dimensional space.

## Appeal

The *appeal* principle has to do with charisma, believability, and interest. Appeal on the Web includes an easy-to-read design, clear drawing, and motion that will capture and involve the visitor's interest. The animation has to appeal to the mind as well as to the eye.

There's a nice video explaining the 12 principles of animation at <https://vimeo.com/93206523>, and a nice display of all of the principles can be found at [The Illusion of Life](#).

# Animation and Transition Considerations

Flash animation, animated banner ads, and Geocities animated GIFs from 1996 have given animation a bad name. In reality, it isn't that animation itself is bad; it's the way those animations were implemented that led to bad user experiences. With CSS, we can create animations and transitions that improve and augment user experience. Animation can give the appearance of life to two-dimensional, lifeless objects and give understanding to objects that have no meaning. But with great power comes great responsibility.

Animations can be used for good: a small animation can help inform the user that the state of an object has changed, or can occupy the user's attention so they don't notice a slow loading time.

The most important principle is timing and it's the most difficult to fine-tune. Unlike cartoons, timing in CSS means milliseconds, not frames. There is no magic value of milliseconds for the duration. Depending on the timing function, you may want to add a few milliseconds for the effect to feel natural. A developer-defined cubic Bézier timing function that creates a bounce might work better with a bit more time than a simple `ease-in` timing function. Just ensure the animation is short enough for your site to feel responsive rather than slow.

If you have many animations in your site or application, think of timing as a choreography of animations. There is no "right" number of animations. It's not the number of animations, it's the design behind it.

All your animations should feel related. If there is a mix and match of delays, timings, and timing functions, the animations may seem unrelated. Choreograph your animations to ensure a cohesive feel among all the moving parts. Make sure your animations are making your site more sophisticated, more modern, and more trustworthy.

It is up to your designers to design animations that have purpose and style.  
It's up to this book to teach you how to implement those animations.

# Chapter 10. Transitions

CSS transitions allow us to animate CSS properties from an original value to a new value over time when a property value changes.

Normally, when a CSS property value changes—when a “style change event” occurs—the change is instantaneous. The new property value replaces the old property in the milliseconds it takes to repaint (or reflow and repaint if necessary) the affected content. Most value changes seem instantaneous, taking less than 16 ms<sup>1</sup> to render. Even if the changes takes longer, it is a single step from one value to the next. For example, when changing a background color on hover, the background changes from one color to the next, with no gradual transition. CSS transitions enable us to smoothly animate CSS properties from an original value to a new value over time as the style recomputation proceeds:

```
button {  
    color: magenta;  
    transition: color 200ms ease-in 50ms;  
}  
  
button:hover {  
    color: rebeccapurple;  
    transition: color 200ms ease-out 50ms;  
}
```

Transitions allow the values of CSS animatable properties to change over time, providing for simple animations.<sup>2</sup> For example, instead of instantaneously changing a button’s `color` on hover, with CSS transitions the button can be set to gradually fade from `magenta` to `rebeccapurple` over 200 milliseconds, even adding a 50-millisecond delay before transitioning. Changing a color, no matter how long it takes, is a transition. But by adding the CSS `transition` property, the color change can be gradual.

You can use CSS transitions today, even if you still support IE9 or older browsers. If a browser doesn’t support CSS transition properties, the change will be immediate instead of gradual, which is fine and accessible. If the

property or property values specified aren't animatable, again, the change will be immediate instead of gradual.

Because transitions are simply progressive enhancements, there is no reason to not use them today.

# CSS Transitions

CSS transitions provide a way to control how a property changes from one value to the next over time. We can make the property value change gradually, creating pleasant and, hopefully, unobtrusive effects.

The CSS transition properties can be used to animate CSS property values smoothly, following an acceleration curve, after an optional delay, from a previous value to a new value over a specified length of time. CSS transitions let you decide which properties to animate, how long to wait before the animation starts, how long the transition should take, and how the transition will proceed. All these features are customizable.

Sometimes you want instantaneous value changes. Though we used link colors as an example in the preceding section, link colors should change instantly on hover, informing sighted users an interaction is occurring and that the hovered content is a link. Similarly, options in an autocomplete listbox shouldn't fade in: you want the options to appear instantly, rather than fade in more slowly than the user types. Instantaneous value changes are often the best user experience.

At other times, you might want to make a property value change more gradually, bringing attention to what is occurring.

For example, you may want to make a card game more realistic by taking 200



milliseconds to animate the flipping of a card <sup>3</sup>, as the user may not realize what happened if there is no animation.

As another example, you may want your site's drop-down menus to expand or become visible over 200 milliseconds (instead of instantly) which may be jarring. With CSS transitions, you can make a drop-down menu appear slowly. In [Figure 10-1](#), we are transitioning the submenu's height and opacity



over 200 milliseconds. The menu changes from `hidden` to fully opaque and expanded. This is a common use for CSS transitions, which we will also explore later in this chapter.

default state: 0ms

About	Posts	Topics	Events
-------	-------	--------	--------

midtransition: 100ms

About	Posts	Topics	Events
		CSS3	
		JavaScript	
		HTML5	
		SEO	

hover state, after 200ms

About	Posts	Topics	Events
		CSS3	
		JavaScript	
		HTML5	
		SEO	

Figure 10-1. Transition initial, midtransition, and final state

In this chapter, we cover the four transition properties and the `transition` shorthand that not only make our transition possible but very easy to implement.

# Fallbacks: Transitions Are Enhancements

Transitions have excellent browser support. All browsers, including Safari, Chrome, Opera, Firefox, Edge, and Internet Explorer (starting with IE10) support CSS transitions.

Transitions are user-interface (UI) enhancements. Lack of full support should not prevent you from including them. If a browser doesn't support CSS transitions, the changes you are attempting to transition will still be applied: they will just “transition” from the initial state to the end state instantaneously when the style recomputation occurs.

Your users may miss out on an interesting (or possibly annoying) effect, but will not miss out on any content.

As transitions are generally progressive enhancements, there is no need to polyfill for archaic IE browsers. While you could use a JavaScript polyfill for IE9 and earlier, and prefix your transitions for Android 4.3 and earlier, there is likely little need to do so.

# Transition Properties

In CSS, transitions are written using four transition properties: `transition-property`, `transition-duration`, `transition-timing-function`, and `transition-delay`, along with the `transition` property as a shorthand for the four longhand properties.

To create the drop-down navigation from [Figure 10-1](#), we used all four CSS transition properties:

```
nav li ul {  
    transition-property: transform;  
    transition-duration: 200ms;  
    transition-timing-function: ease-in;  
    transition-delay: 50ms;  
    transform: scale(1, 0);  
    transform-origin: top center;  
}  
nav li:hover ul {  
    transform: scale(1, 1);  
}
```

This example defines the transition for our drop-down navigation example in [Figure 10-1](#). The style change in this scenario is caused by hovering over navigational elements.

## Note

While we are using the `:hover` state for our style change event in our transition examples, you can transition properties in other scenarios too. For example, you might add or remove a class, or otherwise change the state—say, by changing an input from `:invalid` to `:valid` or from `:checked` to `:not(:checked)`. Or you might append a table row at the end of a zebra-striped table or list item at the end of a list with styles based on `:nth-last-of-type` selectors.

In the navigation pictured in [Figure 10-1](#), the initial state of the nested lists is

`transform: scale(1, 0)` with a `transform-origin: top center`. The final state is `transform: scale(1, 1)`: the `transform-origin` remains the same.

In this example, the transition properties define a transition on the `transform` property: when the new `transform` value is set on `hover`, the nested unordered list will scale to its original, default size, changing smoothly between the old value of `transform: scale(1, 0)` and the new value of `transform: scale(1, 1)` over a period of 200 milliseconds. This transition will start after a 50-millisecond delay, and will ease in, proceeding slowly at first, then picking up speed as it progresses.

Transitions are declared along with the regular styles on an element. Whenever a target property changes, if a transition is set on that property, the browser will apply a transition to make the change gradual. While the most common initiation of a transition is changing property values from a default state to a hovered state, transitions also work if the property is changed by adding a class, manipulating the DOM, or otherwise changing the state.

You can declare transition properties in the initial state, the changed state, or in both the initial and changed states. If you only declare the transition on the initial state, when the state changes, it will transition to the changed state as you indicate with CSS transition properties. If and when it changes back to the initial state, the transition timing is reversed. You can override this default reverse transition by declaring different transitions in both the initial and changed states.

By *initial state*, I mean a state that matches the element on page load. This could be a state that the element always has, such as properties set on an element selector versus a `:hover` state for that element, or a content editable



element that may get `:focus`:

```
/* selector that matches element all the time */
p[contenteditable] {
    background-color: rgba(0, 0, 0, 0);
}
```

```

/* selector that matches element some of the time */
p[contenteditable]:focus {
    /* overriding declaration */
    background-color: rgba(0, 0, 0, 0.1);
}

```

In this example, the fully transparent declaration is always the initial value, changing when the user gives it focus. This is what I mean when I use *initial* or *default* value throughout this chapter. The transition properties included in the selector that matches the element all the time will impact that element whenever the state changes, whether it is from the initial state to the focused state (as in the preceding example) or any other altered state, such as a hover state; or when properties are changed with the dynamic addition of a class.

An initial state could also be a temporary state that may change, such as a `:checked` checkbox or a `:valid` form control, or even a class that gets toggled on and off:

```

/* selector that matches element some of the time */
input:valid {
    border-color: green;
}

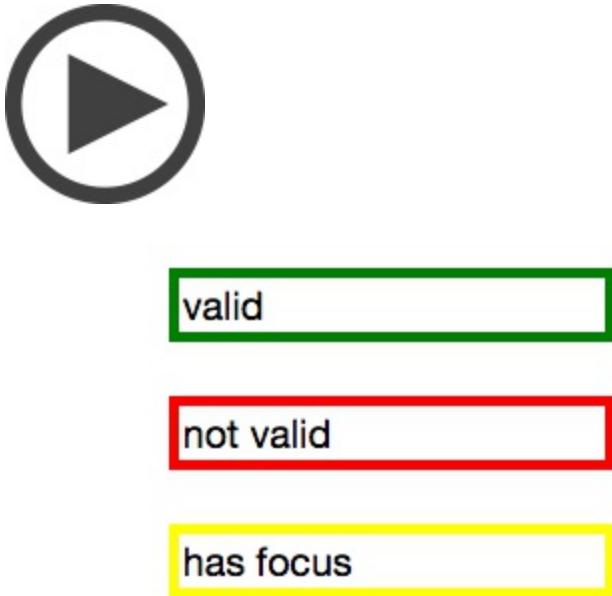
/* selector that matches element some of the time,
   when the prior selector does NOT match. */
input:invalid {
    border-color: red;
}

/* selector that matches element some of the time,
   whether the input is valid or invalid */
input:focus {
    /* alternative declaration */
    border-color: yellow;
}

```

In this example, either the `:valid` or `:invalid` selector matches, but never both. The `:focus` selector, as shown in [Figure 10-2](#), matches some of the time, when the input has focus, whether the input is matching the `:valid` or `:invalid` selector simultaneously. In this case, when we refer to the initial state, we are referring to the original value, which could be either `valid` or `invalid`. In this scenario, the changed state can be the opposite of the initial

`:valid` or `:invalid` value. The `:focus` state is another altered state.



**Figure 10-2.** The input's appearance in the valid, invalid, and focused states

Generally, you want to declare the transition properties at minimum on the selector that applies to the element all the time. In the preceding `contenteditable` scenario, it is the first rule. The second scenario is not as clear-cut: if the transition is only set on the `:invalid` state, the color will transition from red to green as the state of the input changes from invalid to valid, and it will transition from red to yellow when an invalid input receives focus. However, it will not slowly transition from green to yellow, or yellow back to green, when a valid input receives or loses focus. Similarly, the border will transition as it changes from or to the invalid state with a red border; if the input is valid, there will be no transition when the user gives or removes focus.

In this second scenario, we could put the transition on the `:focus` selector, as generally the value will change from `valid` to `invalid` or the reverse when the input has focus. Preferably, however, you will want to put the transition on both the possible initial states, or all three states.

In other words, if you always want the property to transition, you likely want to put the transition on *all* the states. The transition properties that are used

are the ones in the *destination state*; the new values of the transition properties are used to transition to the new value of the property:

```
nav li ul {  
    transition-property: transform;  
    transition-duration: 200ms;  
    transition-timing-function: ease-in;  
    transition-delay: 50ms;  
    transform: scale(1, 0);  
    transform-origin: top center;  
}  
nav li:hover ul {  
    transition-property: transform;  
    transition-duration: 2s;  
    transition-timing-function: linear;  
    transition-delay: 1s;  
    transform: scale(1, 1);  
}
```

This provides a horrible user experience, but I've included it to show a point.



When hovered over, the opening of the navigation takes a full two seconds. When closing, it quickly closes over 0.2 seconds. The transition properties in the destination or hover state are used when hovering over the list item. When no longer hovered over, as it returns to the default scaled-down state, the transition properties of the default properties it is returning to —the `nav li ul` condition—are used.

In our example, we don't want horrible UX. We will omit the slow transition, and instead allow the browser to reverse the transition on mouse out:



```
nav li ul {  
    transition-property: transform;  
    transition-duration: 200ms;  
    transition-timing-function: ease-in;
```

```
    transition-delay: 50ms;
    transform: scale(1, 0);
    transform-origin: top center;
}
nav li:hover ul {
    transform: scale(1, 1);
}
```

To create a simple CSS hover transition, such as the expansion of nested list items in the preceding navigation example, we declare property values in two states: the default or initial state of the element and the hovered state of the element. The initial or original state of the element is declared in the default style declaration. The changed properties, or final or destination state of the element, are declared within a `:hover` style block. If no transition is set, the nested unordered list scales to its default height instantly on hover.

To transition this expansion, we add the transition functions using the `transition-*` properties of `transition-property`, `transition-duration`, `transition-timing-function`, and `transition-delay`, or the `transition` shorthand. In our example, we will be adding the transition properties only in the default style declaration. When the transition is declared in the style block of the initial state of the element, the transition will be applied as the element changes from the initial state to the changed or destination state and applied in reverse as it changes back to the initial state from the changed state.

In our example, when the user stops hovering over the parent navigational element or the child drop-down menu, the drop-down menu will wait 50 milliseconds before closing over 200 milliseconds, using `ease-out` as the timing function, reversing the transition declared in the default state. As we saw in our bad UX example, the reverse transition timing function, duration, and delay in the reverting direction can be overridden by providing different transition property values in the default and changed-state style blocks.

While the four transition properties can be declared separately, you will probably always use the shorthand. We'll take a look at the four properties individually first so you have a good understanding of what each one does, and then we'll cover the `transition` shorthand, which is what you will likely use in your code.

Let's look at the four properties in greater detail.

# The transition-property Property

The `transition-property` property specifies the names of the CSS properties you want to transition. And, yes, it's weird to say "the `transition-property` property."

`transition-property`

**Values:**      `none` | `<single-property>`#

**Initial value:** `all`

**Applies to:** All elements, `:before` and `:after` pseudo-elements

**Inherited:** No

The value for the `transition-property` is a comma-separated list of properties; the keyword `none` if you want no properties transitioned; or the default `all`, which means "transition all the transitional properties." You can also include the keyterm `all` within a comma-separated list of properties.

If you include `all` as the only keyterm—or default to `all`—all the transitional properties will transition in unison.

Let's say you want to change a box's appearance on hover:

```
div {  
  color: #ff0000;  
  border: 1px solid #00ff00;  
  border-radius: 0;  
  transform: scale(1) rotate(0deg);  
  opacity: 1;
```

```

        box-shadow: 3px 3px rgba(0, 0, 0, 0.1);
        width: 50px;
        padding: 100px;
    }
    div:hover {
        color: #000000;
        border: 5px dashed #000000;
        border-radius: 50%;
        transform: scale(2) rotate(-10deg);
        opacity: 0.5;
        box-shadow: -3px -3px rgba(255, 0, 0, 0.5);
        width: 100px;
        padding: 20px;
    }
}

```

When the user hovers over the `div`, every property that has a different value in the default state versus the hovered state will change to the hover-state values. We use the `transition-property` property to define which of those properties we want to animate over time (versus instantly). All the properties will change from the default value to the hovered value on `hover`, but only the animatable properties included in the `transition-property` will transition over time. Nonanimatable properties like `border-style` will change from one value to the next instantly. See “[“Transitionable properties”](#)”.

## **all**

If you want to define all the properties to transition at the same time, speed, and pace, use `all`. If `all` is the only value or the last value in the comma-separated value for `transition-property`, all the animatable properties will transition in unison.

If we want to transition all the properties, the following statements are almost equivalent:

```

div {
    color: #ff0000;
    border: 1px solid #00ff00;
    border-radius: 0;
    transform: scale(1) rotate(0deg);
    opacity: 1;
    box-shadow: 3px 3px rgba(0, 0, 0, 0.1);
    width: 50px;
}

```

```
padding: 100px;
transition-property: color, border, border-radius, transform,
    box-shadow, width, padding;
transition-duration: 1s;
}
```

and

```
div {
    color: #ff0000;
    border: 1px solid #00ff00;
    border-radius: 0;
    transform: scale(1) rotate(0deg);
    opacity: 1;
    box-shadow: 3px 3px rgba(0, 0, 0, 0.1);
    width: 50px;
    padding: 100px;
    transition-property: all;
    transition-duration: 1s;
}
```

Both `transition-property` property declarations will transition all the properties listed—but the former will transition only the eight properties that may change, based on property declarations that may be included in other rule blocks. Those eight property values are included in the same rule block, but they don't have to be.

The `all` in the latter example ensures that *all* animatable property values that would change based on any style change event—no matter which CSS rule block includes the changed property value—transitions over one second. The transition applies to all animatable properties of all elements matched by the selector, not just the properties declared in the same style block as the `all`.

Declaring individual properties means only the properties specifically defined in the value of the `transition-property` transition when the value gets changed—whether those property values are inherited, declared in the same rule block, or applied to the element via a different CSS rule block.

In this case, the first version limits the transition to only the eight properties listed, but enables us to provide more control over how each property will transition. Declaring the properties individually lets us provide different speeds, delays, and/or durations to each property's transition if we declared

those transition properties separately:

```
<div class="foo">Hello</div>

div {
    color: #ff0000;
    border: 1px solid #0f0;
    border-radius: 0;
    transform: scale(1) rotate(0deg);
    opacity: 1;
    box-shadow: 3px 3px rgba(0, 0, 0, 0.1);
    width: 50px;
    padding: 100px;
}

.foo {
    color: #00ff00;
    transition-property: color, border, border-radius, transform,
        box-shadow, width, padding;
    transition-duration: 1s;
}
```

The `transition-property` property does not need to be in the same rule block as the properties that make up its value.

If you want to define the transitions for each property separately, write them all out, separating each of the properties with a comma. If you want to animate almost all the properties at the same time, delay, and pace, with a few exceptions, you can use a combination of `all` and the individual properties you want to transition at different times, speeds, or pace. Make sure to use `all` as the first value:

```
div {
    color: #f00;
    border: 1px solid #00ff00;
    border-radius: 0;
    transform:
        scale(1) rotate(0deg);
    opacity: 1;
    box-shadow: 3px 3px rgba(0, 0, 0, 0.1);
    width: 50px;
    padding: 100px;
    transition-property: all, border-radius,
        opacity; transition-duration: 1s, 2s, 3s;
}
```

The `all` part of the comma-separated value includes all the properties listed in the example, as well as all the inherited CSS properties, and all the properties defined in any other CSS rule block matching or inherited by the element. In the preceding example, all the properties getting new values will transition at the same duration, delay, and timing function, with the exception of `border-radius` and `opacity`, which we've explicitly included separately. Because we included them as part of a comma-separated list after the `all`, we can transition them at the same time, delay, and timing function as all the other properties, or we can provide different times, delays, and timing functions for these two properties. In this case, we transition all the properties over one second, except for `border-radius` and `opacity`, which we transition over two seconds and three seconds, respectively. We cover `transition-duration` next.

#### Note

Make sure to use `all` as the first value in your comma-separated value list, as the properties declared before the `all` will be included in the `all`, overriding any other transition property values you intended to apply to those now overridden properties.

#### **none**

While transitioning over time doesn't happen by default, if you do include a CSS transition and want to override that transition in a particular scenario, you can set `transition-property: none` to override the entire transition and ensure no properties are transitioned. The `none;` keyword can only be used as a unique value of the property—you can't include it as part of a comma-separated list of properties. If you want to override the animation of fewer than all the properties, you will have to list all of the properties you still want to transition. You can't use the `transition-property` property to exclude properties; rather, you can only use that property to include them. Another trick would be to set the delay and duration of the property to `0s`. That way it will appear instantaneously: no CSS transition is being applied to it.

## Transitable properties

Not all properties are transitionable, and not all values of some normally transitionable properties can be transitioned. There is a finite list of CSS 2.1 properties that are animatable, which is summarized in “[Animatable Properties](#)”. Realize that as CSS is evolving, new properties are being added. While the animatable properties list is not worth memorizing, the general rule is that if there is a logical midpoint between the initial value and the final value of a property, that property and value type is probably animatable.

By “property and value type,” I mean that some properties are animatable, but not all values of those properties are animatable. Numeric values tend to be animatable; keyword values that can’t be converted to numeric values generally aren’t. Keywords that represent computed values, like `red` (which is converted to an RGB value) are animatable. Keyterms that aren’t computed values, like `auto` in `top: auto`, are not. CSS functions that take numeric values as parameters generally are animatable. For example, you can transition from `height: 0` to `height: 200px` as both values are numeric. But even though `height` is an animatable property, `height: auto` is *not* an animatable value, as `auto` in this case is not a computed value.

You *can* transition from `color: red` to `color: slategray`, as the browser converts the colors from named colors to hexadecimal values, which are numeric; the browser can determine the midpoint between two numeric values.

If you accidentally included a property that can’t be transitioned, fear not. The browser will simply not transition the property that is not animatable. The entire declaration will not fail. The nonanimatable property or nonexistent CSS property is not exactly ignored. The browser passes over unrecognized or nonanimatable properties, keeping their place in the property list order to ensure that the other comma-separated transition properties described next are not applied on the wrong properties.<sup>4</sup>

#### Note

Transitions can only occur on properties that are not currently being impacted by a CSS animation. If the element is being animated, properties may still transition, as long as they are not properties that are currently controlled by

the animation. CSS animations are covered in [Chapter 11](#).

The behavior of transitions seemingly not adhering to the basics of CSS cascades when an animation on the same element and property is running does not affect whether the transition has started or ended. The cascade is actually being adhered to. Transition events will still fire, confirming the transition occurred.

The length of the `transition-property` list determines the number of items in the `transition-duration`, `transition-timing-function`, and `transition-delay` lists. If the number of values in any or all of these three properties does not match the number of values listed in the `transition-property` value, the browser will ignore any excess values, or repeat values when these other properties have fewer values in their comma-separated list than the `transition-property` property. For this reason, the order of the values in the `transition-property` value may be important, just as it is important for other transition properties.

If you include a property that is not animatable (like a `border-style` value change) or a nonexistent property (such as a property name with a typo in it), the `transition-property` will still work. Unrecognized words or properties that are not animatable are not ignored. Rather, they are kept in the list of properties to ensure that values from other comma-separated transition properties, such as `transition-duration`, are applied in the right order.

However, if you have a syntax error, like a missing comma between two property names or a space within a property name, that `transition-property` property declaration will be ignored. Similarly, if you include the terms `none`, `inherit`, or `initial`, as per the specification, the entire property exists, but fails, so should be ignored. This is not the case in some browsers, however. Safari 8 and IE Edge 12 treat `none`, `inherit`, and `initial` in a list of comma-separated properties as unrecognized or nonanimatable properties.

## Transition event: `transitionend`

A `transitionend` event occurs at the end of every transition, in each direction, for every property that is transitioned over any amount of time or

after any delay, whether the property is declared individually or is part of the `all` declaration. For some seemingly single property declarations, there will be several `transitionend` events, as every animatable property within a shorthand property gets its own `transitionend` event.

In the preceding example, when the transition concludes, there will be well over eight `transitionend` events. For example, the `border-radius` transition alone produces four `transitionend` events, one each for:

```
border-bottom-left-radius  
border-bottom-right-radius  
border-top-right-radius  
border-top-left-radius
```

The `padding` property is also a shorthand for four longhand properties:

```
padding-top  
padding-right  
padding-bottom  
padding-left
```

The `border` shorthand property produces eight `transitionend` events: four values for `border-width` and four for `border-color`, both of which are shorthand declaration themselves:

```
border-left-width  
border-right-width  
border-top-width  
border-bottom-width  
border-top-color  
border-left-color  
border-right-color  
border-bottom-color
```

There are no `transitionend` events for `border-style` properties, as `border-style` is not an animatable property.

How do we know it's not animatable? We can assume it isn't, since there is no logical midpoint between the two values of `solid` and `dashed`. We can confirm by looking up the [list of animatable properties](#) or the specifications for the individual properties.

There will be 21 `transitionend` events in our scenario in which 8 specific properties are listed, as those 8 include several shorthand properties that have different values in the pre and post states. In the case of `all`, there will be at least 21 `transitionend` events: one for each of the longhand values making up the 8 properties we know are included in the pre and post states, and possibly from others that are inherited or declared in other style blocks



impacting the element:

```
document.querySelector('div').addEventListener('transitionend',
  function (e) {
    console.log(e.propertyName);
});
```

The `transitionend` event includes three event specific attributes: 1) `propertyName`, which is the name of the CSS property that just finished transitioning; 2) `pseudoElement`, which is the pseudoelement upon which the transition occurred, preceded by two semicolons, or an empty string if the transition was on a regular DOM node; and 3) `elapsedTime`, which is the amount of time the transition took to run, in seconds, which is generally the time listed in the `transition-duration` property.

The `transitionend` event only occurs if the property successfully transitions to the new value. The `transitioned` event doesn't fire if the transition was interrupted by another change to the same property on the same element.

When the properties return to their initial value, another `transitionend` event occurs. This event occurs as long as the transition started, even if it didn't finish transitioning in the original direction.

# The transition-duration Property

The `transition-duration` property takes as its value a comma-separated list of lengths of time, in seconds (`s`) or milliseconds (`ms`), it should take to transition from the original property values to the final property values.

`transition-duration`

**Values:**      `<time>#`

**Initial value:** `0s`

**Applies to:** All elements, `:before` and `:after` pseudo-elements

**Inherited:** No

The `transition-duration` property dictates how long it should take for each property to transition from the original value to the new value. If reverting between two states, and the duration is only declared in one of those states, the transition will take the amount of time declared to revert to the previous state:

```
input:invalid {  
    transition-duration: 1s;  
    background-color: red;  
}  
  
input:valid {  
    transition-duration: 0.2s;  
    background-color: green;  
}
```

If different values for the `transition-duration` are declared, the duration of

the transition will be the `transition-duration` value declared in the rule block it is transitioning to. In the preceding example, it will take 1 second for the input to change to a red background when it becomes invalid, and only 200 milliseconds to transition to a green background when it becomes valid.



The value of the `transition-duration` property should be declared as a positive value in either seconds (`s`) or milliseconds (`ms`). The time unit of `ms` or `s` is required by the specification, even if the duration is set to `0s`. By default, properties simply change from one value to the next instantly. In line with this, the default value for the duration of a transition is `0s`, meaning the transition is immediate, showing no animation.

Unless there is a positive value for `transition-delay` set on a property, if `transition-duration` is omitted, it is as if no `transition-property` declaration had been applied—with no `transitionend` event occurring. As long as the total time set for a transition to occur is greater than `0s`—which can happen with a duration of `0s` or when the `transition-duration` is omitted and defaults to `0s`, if there is a positive `transition-delay` value—the transition will still be applied and a `transitionend` event will occur if the transition finishes.

Negative values for `transition-duration` are invalid, and, if included, will invalidate the entire property value.

Using the same super-long `transition-property` declaration, we can declare a single duration for all the properties or individual durations for each property, or we can make alternate properties animate for the same length of time. We can declare a single duration that applies to all properties during the transition by including a single `transition-duration` value:

```
div {  
  color: #ff0000;  
  ...  
  transition-property: color, border, border-radius, transform,
```

```
    box-shadow, width, padding;
    transition-duration: 200ms;
}
```

We could have instead declared the same number of comma-separated time values for the `transition-duration` property value as the CSS properties we enumerated in the `transition-property` property value. If we want each property to transition over a different length of time, we have to include a different comma-separated value for each property name declared:

```
div {
  color: #ff0000;
  ...
  transition-property: color, border, border-radius, transform,
    box-shadow, width, padding;
  transition-duration: 200ms, 180ms, 160ms, 140ms, 120ms, 100ms
}
```

If the number of properties declared does not match the number of durations declared, the browser has specific rules on how to handle the mismatch. If there are more durations than properties, the extra durations are ignored. If there are more properties than durations, the durations are repeated. In this example, `color`, `border-radius`, `opacity`, and `width` have a duration of 100 ms; `border`, `transform`, `box-shadow`, and `padding` will be set to 200 ms:

```
div {
  ...
  transition-property: color, border, border-radius, transform,
    box-shadow, width, padding;
  transition-duration: 100ms, 200ms;
}
```

If we declare exactly two comma-separated durations, every odd property will transition over the first time declared, and every even property will transition over the second time value declared.

If a transition is too slow, the website will appear slow or unresponsive, drawing unwanted focus to what should be a subtle effect. If a transition is too fast, it may be too subtle to be noticed. While you can declare any positive length of time you want for your transitions, your goal is likely to provide an enhanced rather than annoying user experience. Effects should last

long enough to be seen, but not so long as to be noticeable. Generally, the best effects range between 100 and 200 milliseconds, creating a visible, yet not distracting, transition.

We want a good user experience for our drop-down menu, so we set both properties to transition over 200 milliseconds:

```
nav li ul {  
    transition-property: transform, opacity;  
    transition-duration: 200ms;  
    ...  
}
```

# The transition-timing-function Property

Do you want your transition to start off slow and get faster, start off fast and end slower, advance at an even keel, jump through various steps, or even bounce? The `transition-timing-function` provides a way to control the pace of the transition. The `transition-timing-function` property describes how the transition proceeds as it is being executed.

`transition-timing-function`

**Values:** <timing-function>#

**Initial value:** `ease`

**Applies to:** All elements, `:before` and `:after` pseudo-elements

**Inherited:** No

The `transition-timing-function` values include `ease`, `linear`, `ease-in`, `ease-out`, `ease-in-out`, `step-start`, `step-end`, `steps(n, start)`—where `n` is the number of steps—`steps(n, end)`, and `cubic-bezier(x1, y1, x2, y2)`. These values are also the valid values for the `animation-timing-function` and are described in great detail in [Chapter 11](#).

The non-step keyword are easing timing functions employing cubic Bézier mathematical functions to provide smooth curves. The specification provides for five predefined easing functions, but you can describe your own precise timing function by defining your own `cubic-bezier()` function, as shown in [Table 10-1](#).

Table 10-1. Supported keyterms for cubic Bézier timing functions

Timing function	Definition	cubic-bezier value
ease	Starts slow, then speeds up, then ends very slowly	cubic-bezier(0.25, 0.1, 0.25, 1)
linear	Proceeds at the same speed throughout transition	cubic-bezier(0, 0, 1, 1)
ease-in	Starts slow, then speeds up	cubic-bezier(0.42, 0, 1, 1)
ease-out	Starts fast, then slows down	cubic-bezier(0, 0, 0.58, 1)
ease-in-out	Similar to ease; faster in the middle, with a slow start but not as slow at the end	cubic-bezier(0.42, 0, 0.58, 1)
cubic-bezier()	Specifies a cubic-bezier curve	cubic-bezier(x1, y1, x2, y2)

Cubic Bézier curves, including the underlying curves defining the five named easing functions defined in [Table 10-1](#) and displayed in [Figure 10-3](#), take four numeric parameters. For example, `linear` is the same as `cubic-bezier(0, 0, 1, 1)`. The first and third cubic Bézier function parameter values need to be between 0 and +1.

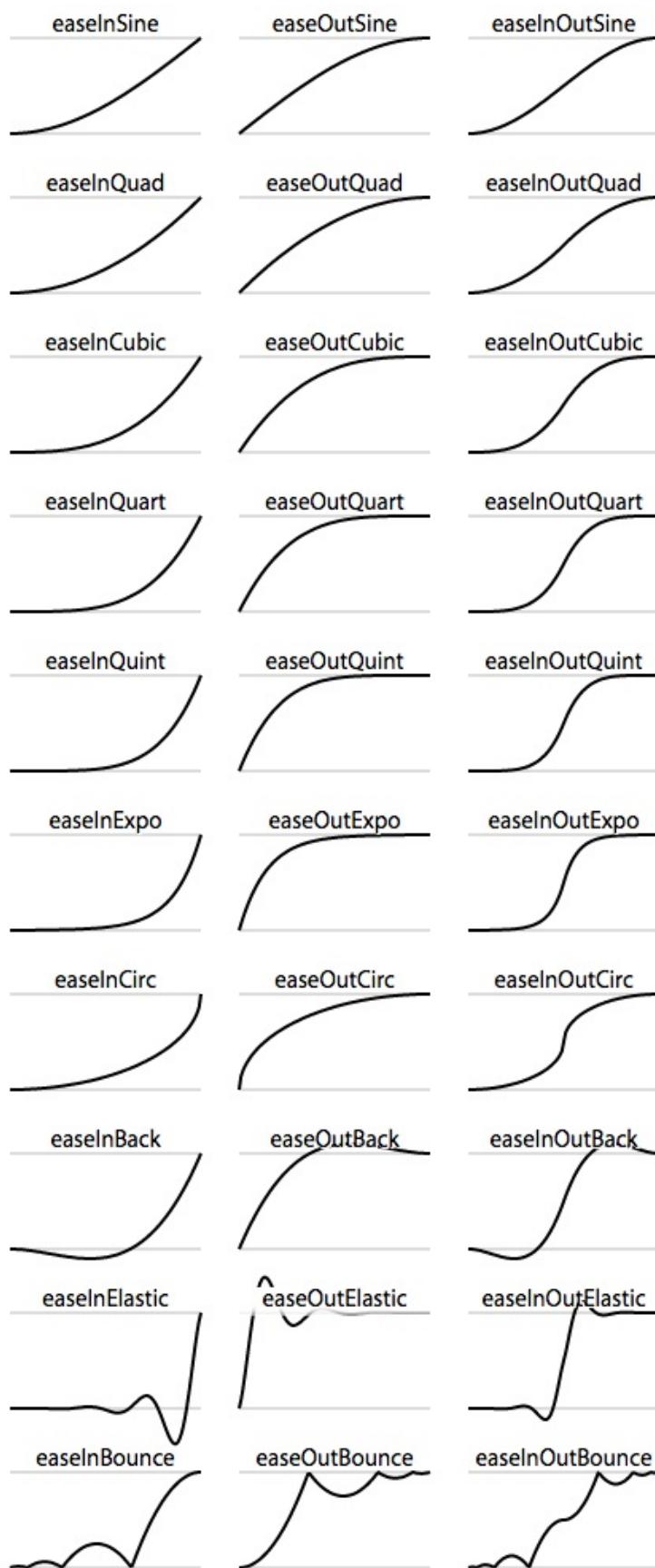


**Figure 10-3.** Supported cubic Bézier named functions include `ease`, `linear`, `ease-in`, `ease-out`, and `ease-in-out`

If you've taken six years of calculus, the method of writing a cubic Bézier function might make sense; otherwise, it's likely you'll want to stick to one of the five basic timing functions. There are online tools that let you play with different values, such as [cubic-bezier.com](http://cubic-bezier.com), which lets you compare the common keywords against each other, or against your own cubic Bézier function.

The predefined key terms are fairly limited. To better follow the principles of animation (refer back to “[12 Basic Principles of Animation](#)”), you may want to use a cubic Bézier function with four float values instead of the predefined key words.

As shown in [Figure 10-4](#), the website [easings.net](#) provides many additional cubic Bézier function values you can use to provide for a more realistic, delightful animation.



**Figure 10-4. Useful author-defined cubic Bézier functions**

While the authors of the site named their animations, the preceding names are not part of the CSS specifications, and must be written as follows:

<b>Unofficial name</b>	<b>Cubic Bézier function value</b>
easeInSine	cubic-bezier(0.47, 0, 0.745, 0.715)
easeOutSine	cubic-bezier(0.39, 0.575, 0.565, 1)
easeInOutSine	cubic-bezier(0.445, 0.05, 0.55, 0.95)
easeInQuad	cubic-bezier(0.55, 0.085, 0.68, 0.53)
easeOutQuad	cubic-bezier(0.25, 0.46, 0.45, 0.94)
easeInOutQuad	cubic-bezier(0.455, 0.03, 0.515, 0.955)
easeInCubic	cubic-bezier(0.55, 0.055, 0.675, 0.19)
easeOutCubic	cubic-bezier(0.215, 0.61, 0.355, 1)
easeInOutCubic	cubic-bezier(0.645, 0.045, 0.355, 1)
easeInQuart	cubic-bezier(0.895, 0.03, 0.685, 0.22)
easeOutQuart	cubic-bezier(0.165, 0.84, 0.44, 1)

```
easeInOutQuart cubic-bezier(0.77, 0, 0.175, 1)

easeInQuint    cubic-bezier(0.755, 0.05, 0.855, 0.06)

easeOutQuint   cubic-bezier(0.23, 1, 0.32, 1)

easeInOutQuint cubic-bezier(0.86, 0, 0.07, 1)

easeInExpo     cubic-bezier(0.95, 0.05, 0.795, 0.035)

easeOutExpo    cubic-bezier(0.19, 1, 0.22, 1)

easeInOutExpo  cubic-bezier(1, 0, 0, 1)

easeInCirc     cubic-bezier(0.6, 0.04, 0.98, 0.335)

easeOutCirc    cubic-bezier(0.075, 0.82, 0.165, 1)

easeInOutCirc  cubic-bezier(0.785, 0.135, 0.15, 0.86)

easeInBack     cubic-bezier(0.6, -0.28, 0.735, 0.045)

easeOutBack    cubic-bezier(0.175, 0.885, 0.32, 1.275)

easeInOutBack  cubic-bezier(0.68, -0.55, 0.265, 1.55)
```

There are also step timing functions available, with two predefined step values:

## Timing function

## Definition

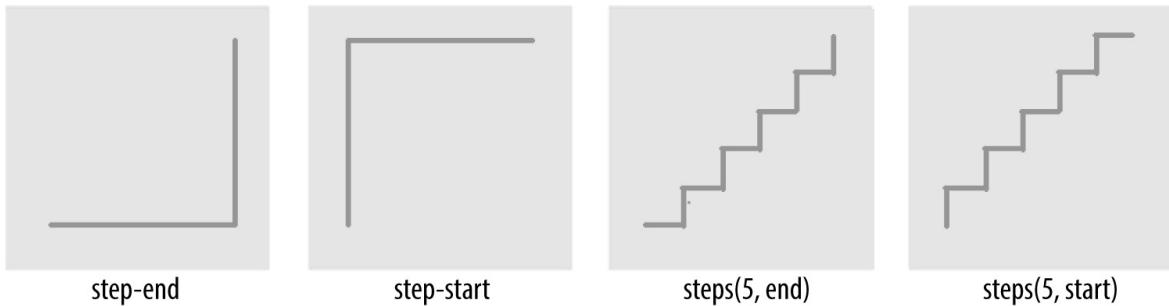
`step-start` Stays on the final keyframe throughout transition. Equal to `steps(1, start)`.

`step-end` Stays on the initial keyframe throughout transition. Equal to `steps(1, end)`.

`steps(n, start)` Displays  $n$  stillshots, where the first stillshot is  $n/100$  percent of the way through the transition.

`steps(n, end)` Displays  $n$  stillshots, staying on the initial values for the first  $n/100$  percent of the time.

As [Figure 10-5](#) shows, the stepping functions show the progression of the transition from the initial value to the final value in steps, rather than as a smooth curve.



**Figure 10-5.** Step timing functions

The step functions allow you to divide the transition over equidistant steps. The functions define the number and direction of steps. There are two direction options: `start` and `end`. With `start`, the first step happens at the animation start. With `end`, the last step happens at the animation end. For example, `steps(5, end)` would jump through the equidistant steps at 0%,

20%, 40%, 60%, and 80%; and `steps(5, start)` would jump through the equidistant steps at 20%, 40%, 60%, 80%, and 100%.

The `step-start` function is the same as `steps(1, start)`. When you use it, the property value stays on the final value from the beginning until the end of the transition. The `step-end` function, which is the same as `steps(1, end)`, sits on the initial value of the property, staying there through the transition's duration.

Continuing on with the same super-long `transition-property` declaration, we can declare a single timing function for all the properties or individual timing functions for each property, or we can make every even property have one timing function, while every odd property proceeds at a separate pace:

```
div {  
  ...  
  transition-property: color, border-width, border-color, border-  
    transform, opacity, box-shadow, width, padding;  
  transition-duration: 200ms;  
  transition-timing-function: ease-in;  
}
```

In the preceding example, we made all the properties transition at the same tempo by including a single time as the `timing-function` value:

```
div {  
  ...  
  transition-property: color, border-width, border-color, border-  
    transform, opacity, box-shadow, width, padding;  
  transition-duration: 200ms, 180ms, 160ms, 140ms, 120ms, 100ms;  
  transition-timing-function: ease, ease-in, ease-out, ease-in-  
    step-end, step-start, steps(5, start), steps(3, end);  
}
```

We can also create a horrible user experience by making every property transition at a different rhythm. The `transition-timing-function` does not change the time it takes to transition properties: that is set with the `transition-duration` property; but it does change how the transition progresses during that set time:

```
div {  
  ...
```

```
transition-property: color, border-width, border-color, border-transform, opacity, box-shadow, width, padding;
transition-duration: 200ms;
transition-timing-function: ease, ease-in, ease-out, ease-in-step-end, step-start, steps(5, start), steps(3, end);
}
```

If we include these nine different timing functions for the nine different properties, as long as they have the same transition duration and delay, all the properties start and finish transitioning at the same time. The timing function controls how the transition progresses, but does not alter the time it takes for the transition to finish.

These timing functions are described in great detail in [“animation-timing-function”](#). The best way to familiarize yourself with the timing functions is to play with them and see which one works best for the effect you’re looking for. While testing, set a relatively long `transition-duration` to better visualize the difference<sup>5</sup> between the various functions. At higher speeds, you may not be able to tell the difference with the easing function; just don’t forget to set it back to under 200 milliseconds before launching your website:

```
nav li ul {
  transition-property: transform, opacity;
  transition-duration: 200ms;
  transition-timing-function: ease-in;
  ...
}
```

Our navigation example has transitions occurring in two directions: one transition occurs when changing from the default or initial value to the final hovered value. The second transition occurs when the user mouses off the list item and the nested unordered list returns to its previous or initial state. When the user hovers over the drop-down navigation, it transitions open; it transitions closed when the user mouses off.

We want our menu to open and become opaque fairly quickly, while appearing gradual. The `ease-in` value is the best for this. The timing function is reversed in the reverse direction; by default, when returning to the initial values, the transition will run in reverse order, inverting the timing function. It therefore eases in as it opens and eases out as it closes. In this example,

ease-in was used, so the return trip will appear as if it was set to ease-out as it proceeds in the opposite direction, going from open to closed. This is the default behavior, but it can be controlled. Controlling the reverse transition direction is discussed in [“In Reverse: Transitioning Back to Baseline”](#).

# The `transition-delay` Property

The `transition-delay` property enables you to introduce a time delay between when the change that initiates the transition is applied to an element and when the transition begins.

If you hover over an element that has a color change on `hover` without a transition, the color will change immediately. Similarly, a `transition-delay` of `0s` (the default) means the transition will begin immediately—it will start executing as soon as the state of the element is altered. Otherwise, the time value of the `transition-delay` defines the time offset from the moment the property values would have changed (had no `transition` or `transition-property` been applied) until the property values declared in the `transition` or `transition-property` value begins animating to the next value.

`transition-delay`

**Values:**      `<time>#`

**Initial value:** `0s`

**Applies to:** All elements, `:before` and `:after` pseudo-elements

**Inherited:** No

Including a `transition-delay` with a positive number of milliseconds (`ms`) or seconds (`s`) to delay the transition will delay the onset of the transition effect. The time unit, as `s` or `ms`, is required. Negative values of time are valid. The effects you can create with negative `transition-delays` are described in “[Negative values](#)”.

## Tip

Unlike `transition-duration`, negative time values are allowed for the `transition-delay` property.

Continuing with the 8- (or 21-) property `transition-property` declaration, we can make all the properties start transitioning right away by omitting the `transition-delay` property or including it with a value of `0s`—but that's not a very interesting example. For the sake of examples, we could delay the start of all the even-numbered properties, while all the odd-numbered properties start right away, by including two comma-separated values, starting with `0s` or `0ms`:

```
div {  
  ...  
  transition-property: color, border, border-radius, transform,  
    box-shadow, width, padding;  
  transition-duration: 200ms;  
  transition-timing-function: linear;  
  transition-delay: 0s, 200ms;  
}
```

By including `transition-delay: 0s, 200ms` on a series of properties, each taking 200 milliseconds to transition, we make every odd-numbered property begin its transition immediately; all the even-numbered transitions begin their transitions as soon as the odd transitions have completed.

As with `transition-duration` and `transition-timing-function`, when the number of comma-separated `transition-delay` values outnumbers the number of comma-separated `transition-property` values, the extra delay values are ignored. When the number of comma-separated `transition-property` values outnumbers the number of comma-separated `transition-delay` values, the delay values are repeated. In this case, with only two values, the first value (`0s`) is applied to each odd property, providing no delay, and the second value is applied to every even property, providing a 200-millisecond delay. Because we declared the `transition-duration` as `200ms` in this scenario, every evenly numbered property will begin transitioning after 200 milliseconds, which is after every oddly numbered property has finished transitioning:

```
div {  
  ...  
  transition-property: color, border-width, border-color, border  
    transform, opacity, box-shadow, width, padding;  
  transition-duration: 200ms;  
  transition-timing-function: linear;  
  transition-delay: 0s, 0.2s, 0.4s, 0.6s, 0.8s, 1s, 1.2s, 1.4s,  
}
```

We can even declare nine different `transition-delay` values so that each property begins transitioning after the previous property has transitioned. In this example, we declared each transition to last 200 milliseconds with the `transition-duration` property. We then declare a `transition-delay` that provides comma-separated delay values for each property that increment by 200 milliseconds, or 0.2 seconds—the same time as the duration of each property's transition. That means we can make each property start transitioning as soon as the previous property has finished.

We can use math to give every transitioning property different durations and delays, ensuring they all complete transitioning at the same time:

```
div {  
  ...  
  transition-property: color, border-width, border-color, border  
    transform, opacity, box-shadow, width, padding;  
  transition-duration: 1.8s, 1.6s, 1.4s, 1.2s, 1s, 0.8s, 0.6s,  
  transition-timing-function: linear;  
  transition-delay: 0s, 0.2s, 0.4s, 0.6s, 0.8s, 1s, 1.2s, 1.4s,  
}
```

In this example, each property completes transitioning at the 1.8-second mark, but each with a different duration and delay. For each property, the `transition-duration` value plus the `transition-delay` value will add up to 1.8 seconds:

```
div {  
  ...  
  transition-property: color, border-width, border-color, border  
    transform, opacity, box-shadow, width, padding;  
  transition-duration: 200ms;  
  transition-timing-function: linear;  
  transition-delay: 50ms;  
}
```

Generally, you want all the transitions to begin at the same time. You can make that happen by including a single `transition-delay` value, which gets applied to all the properties. In our drop-down menu in [Figure 10-1](#), we include a delay of 50 milliseconds. This delay is not long enough for the user to notice and will not cause the application to appear slow. Rather, a 50-millisecond delay can help prevent the navigation from shooting open unintentionally as the user accidentally passes over, or hovers over, the menu items while moving the cursor from one part of the page or app to another.

## Negative values

A negative time value for `transition-delay` will make the transition begin immediately, partway through the transition. A negative `transition-delay` that is smaller than the `transition-duration` will cause the transition to start



immediately, partway through the transition:

```
div {  
    transform: translateX(0);  
    transition-property: transform;  
    transition-duration: 200ms;  
    transition-delay: -150ms;  
    transition-timing-function: linear;  
}  
div:hover {  
    transform: translateX(200px);  
}
```

For example, if you have a `transition-delay` of `-150ms` on a `200ms` transition, the transition will start three-quarters of the way through the transition and will last 50 milliseconds. In that scenario, with a linear timing function, it will jump to being translated `150px` along the x-axis immediately on hover and then animate the translation from 150 pixels to 200 pixels over 50 milliseconds.

If the absolute value of the negative `transition-delay` is greater than or

equal to the `transition-duration`, the change of property values is immediate, as if no `transition` had been applied, and no `transitionend` event occurs.

When transitioning back from the hovered state to the original state, by default, the same value for the `transition-delay` is applied. In the preceding scenario, with the `transition-delay` not being overridden in the hover state, it will jump 75% of the way back (or 25% of the way through the original transition) and then transition back to the initial state. On `mouseout`, it will jump to being translated 50 pixels along the x-axis and then take 50 milliseconds to return to its initial position of being translated 0 pixels along the x-axis.

## Improving user experience

If you hover over the navigation item from [Figure 10-1](#), you would expect the drop-down menu to appear immediately. But that isn't the user experience we want. The user may unintentionally hover over the navigation while mousing from one section of the document to another. Waiting for the user to hover over the navigation element for 50 milliseconds before opening the drop-down menu isn't enough of a delay to make the site appear slow but is enough of a delay to ensure menus don't seem to be unintentionally flying open:

```
nav li ul {  
    transition-property: transform, opacity;  
    transition-duration: 200ms;  
    transition-timing-function: ease-in;  
    transition-delay: 50ms;  
    transform: scale(1, 0);  
    transform-origin: top center;  
    opacity: 0;  
}  
nav li:hover ul {  
    transform: scale(1, 1);  
    opacity: 1;  
}
```

In our navigation example, we add a 50-millisecond transition delay. This way, our drop-down menu won't transition immediately if the user

accidentally mouses over a link on the way from one part of the document to another. By adding `transition-delay: 50ms`, we can be more confident the user is intentionally hovering over the parent navigation item before opening the drop-down menu.

The browser will also wait 50 milliseconds after the user mouses off the navigational element before transitioning back to the pretransitioned state. When the `transition-delay` is specified somewhere that applies to the element all the time, the `transition-delay` occurs in both transition directions; that means the browser will wait 50 milliseconds after the parent `li` or its descendant loses `hover` before closing the drop-down menu.

This 50-millisecond delay before closing occurs whether or not the menu is completely open or even if the user mouses out of the menu before the menu finishes transitioning open. The browser will wait 50 milliseconds before opening the drop-down menu and will also wait 50 milliseconds before closing it—whether or not it was ever fully visible—as long as it had started to open.

This may seem odd, but it improves user experience. Often users accidentally mouse out of a navigational element as they mouse toward an item in the newly opened submenu. This 50-millisecond delay in the reverse direction gives the user a 50-millisecond window to get back onto the drop-down menu before it closes. This isn't enough time to completely hover off and back on, but if there are submenus, an accidental mousing over nonnavigation space as the user moves the pointer to a subnavigation may be short enough to not close the navigation completely. If the user doesn't hover over the open menu of the parent tab, the menu will transition back to a closed state. This is a good user experience.

If a mouse user leaves the area after the 50-millisecond delay but before the 200-millisecond duration, the menu will not open fully. Rather, there will be a 50-millisecond delay, and then the menu will revert to its fully closed state. Some browsers will take the full 200 milliseconds to revert; others will spend the same amount of time in the reverse direction as they did in the normal direction. A *reversing shortening factor*, which shortens the reverse transition time of incomplete transitions, is defined in the CSS Transitions specifications and is beginning to be implemented in browsers.

## Reverse direction

When a transitioned property reverts from the final state to the initial state and transition properties are only set on the start or initial state, the delay is repeated and the timing is reversed. If the transition is interrupted and doesn't complete, the duration and delay are not ignored as the properties revert.

When a transition is interrupted before it is able to finish (such as mousing off of our drop-down menu example before it finishes opening), property values are reset to the values they had before the transition began, and the properties will transition back to those values. Because repeating the duration and timing functions on a reverting partial transition can lead to an odd or even bad user experience, the CSS transitions specification provides for making the reverting transition shorter.

In our menu example, we have a `transition-delay` of `50ms` set on the default state and no transition properties declared on the hover state; thus, browsers will wait 50 milliseconds before beginning the reverse or closing transition.

When the forward animation finishes transitioning to the final values and the `transitionend` event is fired, all browsers will duplicate the `transition-delay` in the reverse states.

As [Table 10-2](#) shows, if the transition didn't finish—say, if the user moved off the navigation before the transition finished—all browsers except Microsoft Edge will repeat the delay in the reverse direction. Some browsers replicate the `transition-duration` as well, but Edge and Firefox have implemented the specification's reversing shortening factor.

Table 10-2. Unfinished transition reverse behavior by browser

Browser	Reverse delay	Transition time	Elapsed time
---------	---------------	-----------------	--------------

Chrome 37	Yes	200 ms	0.200s
-----------	-----	--------	--------

Chrome 42	Yes	200 ms	0.250s
Safari 8	Yes	200 ms	0.200s
Firefox 41	Yes	38 ms	0.038s
Opera 32	Yes	200 ms	0.250s
Edge 12	No	38 ms	0.038s

Let's say the user moves off that menu 75 milliseconds after it started transitioning. This means the drop-down menu will animate closed without ever being fully opened and fully opaque. The browser should have a 50-millisecond delay before closing the menu, just like it waited 50 milliseconds before starting to open it. This is actually a good user experience, as it provides a few milliseconds of delay before closing, preventing jerky behavior if the user accidentally navigates off the menu. As shown in [Table 10-2](#), all browsers do this, except Microsoft Edge. In cases where the original transition has completed, all browsers, including Edge, will repeat the 50-millisecond delay before reverting the transition and closing the menu—but if the original transition did not have time to conclude, Microsoft Edge currently does not wait before reversing the transition. This is true for positive `transition-delay` values.

Even though we only gave the browser 75 milliseconds to partially open the drop-down menu before closing the menu, some browsers will take 200 milliseconds—the full value of the `transition-duration` property—to revert. Other browsers, including Firefox and Edge, have implemented the CSS specification's reversing shortening factor and the reversing-adjusted start value. When implemented, the time to complete the partial transition in the reverse direction will be similar to the original value, though not necessarily exact. For step timing functions, it will be the time it took to complete the last completed step. For `linear` timing functions, the partial

durations will be the same in both directions. In the case of our `ease-in` 75-millisecond partial transition duration, the reverse duration is 38.4 milliseconds:

```
div {  
    width: 100px;  
    transition: width 10s steps(10, start);  
}  
div:hover {  
    width: 200px;  
}
```

In the case of a `steps` timing function, Firefox and Edge will take the time, rounded down to the number of steps the function has completed. For example, if the transition was 10 seconds with 10 steps, and the properties reverted after 3.25 seconds, ending a quarter of the way between the third and fourth steps (completing 3 steps, or 30% of the transition) it will take 3 seconds to revert to the previous values. In the preceding example, the width of our `div` will grow to 130 pixels wide before it begins reverting back to 100 pixels wide on mouseout.

While the reverse duration will be rounded down to the time it took to the last step, the reverse *direction* will be split into the originally declared number of steps, not the number of steps that completed. In our 3.25-second case, it will take 3 seconds to revert through 10 steps. These reverse transition steps will be shorter in duration at 300 milliseconds each, each step shrinking the width by 3 pixels, instead of 10 pixels.

If we were animating a sprite by transitioning the `background-position`



, this would look really bad. The specification and implementation may change to make the reverse direction take the same number of steps as the partial transition. Other browsers currently take 10 seconds, reverting the progression of the 3 steps over 10 seconds across 10 steps—taking a full second to grow the width in 3-pixel steps.

Browsers that haven't implemented shortened reversed timing, including

Chrome, Safari, and Opera, will take the full 10 seconds, instead of only 3, splitting the transition into 10 steps, to reverse the 30% change. Whether the initial transition completed or not, these browsers will take the full value of the initial transition duration, less the absolute value of any negative `transition-delay`, to reverse the transition, no matter the timing function. In the steps case just shown, the reverse direction will take 10 seconds. In our navigation example, it will reverse over 200 milliseconds, whether the navigation has fully scaled up or not.

For browsers that have implemented the reversing timing adjustments, if the timing function is linear, the duration will be the same in both directions. If the timing function is a step function, the reverse duration will be equal to the time it took to complete the last completed step. All other cubic-bezier functions will have a duration that is [proportional to progress the initial transition made before being interrupted](#). Negative `transition-delay` values are also proportionally shortened. Positive delays remain unchanged in both directions.

No browser will have a `transitionend` for the hover state, as the transition did not end; but all browsers will have a `transitionend` event in the reverse state when the menu finishes collapsing. The `elapsedTime` for that reverse transition depends on whether the browser took the full 200 milliseconds to close the menu, or if the browser takes as long to close the menu as it did to partially open the menu. Chrome and Opera include the delay in their `elapsedTime` value. As of early 2016, this is a bug, and should be fixed soon. All other browsers include only the time the browser spent transitioning back —75 milliseconds for Firefox and Edge, 200 milliseconds for Safari and older versions of Chrome and Android.

To override these values, include transition properties in both CSS rule blocks. While this does not impact the reverse shortening, it does provide more control.

We'll first cover the `transition` shorthand property, then we'll use that property to set different transitions in the reverse direction.

# The transition Shorthand Property

The `transition` shorthand property combines the four properties just described—`transition-property`, `transition-duration`, `transition-timing-function`, and `transition-delay`—into a single property.

`transition`

**Values:** <single-transition>#

**Initial value:** `all 0s ease 0s`

**Applies to:** All elements, `:before` and `:after` pseudo-elements

**Inherited:** No

The `transition` property accepts the value of `none` or any number of comma-separated list of *single transitions*. A single transition contains a single property to transition, or the keyword `all` to transition all the properties—preferably the duration for the transition, and optionally, the timing function and delay.

If a single transition within the `transition` shorthand omits the property to transition (or the keyword `all`), the single transition will default to `all`. If the `transition-timing-function` value is omitted, it will default to `ease`. If only one time value is included, that will be the duration, and there will be no delay, as if `transition-delay` were set to `0s`. If two time values are included, the first is the `transition-duration` and the second is the `transition-delay`.

Within each single transition, the order of the duration versus the delay is

important: the first value that can be parsed as a time will be set as a duration. If an additional time value is found before the comma or the end of the statement, that will be set as the delay:

```
nav li ul {  
    transition: transform 200ms ease-in 50ms,  
                opacity 200ms ease-in 50ms;  
    ...  
}  
  
nav li ul {  
    transition: all 200ms ease-in 50ms;  
    ...  
}  
  
nav li ul {  
    transition: 200ms ease-in 50ms;  
    ...  
}
```

The shorthand for our drop-down menu can be written three different ways. In the first example, we included shorthand for each of the two properties. Because we are transitioning all the properties that change on `hover`, we could use the keyword `all`, as shown in the second example. And, as `all` is the default value, we could write the shorthand with just the duration, timing-function and delay. Had we used `ease` instead of `ease-in`, we could have omitted the timing function, since `ease` is the default.

We had to include the duration, or no transition would be visible. In other words, the only portion of the `transition` property that can be considered required is `transition-duration`.

If we simply wanted to delay the change from closed menu to open menu without a gradual transition, we would still need to include a duration of `0s`. Remember, the first value parsable as time will be set as the duration, and the second one will be set as the delay:

```
nav li ul {  
    transition: 0s 200ms; ...
```

#### Warning

This navigation will wait 200 milliseconds, then show the drop-down fully open and opaque with no gradual transition. This is horrible user experience. Though if you switch the selector from `nav li ul` to `*`, it might make for an April Fools' joke.

If there is a comma-separated list of transitions (versus just a single declaration) and the word `none` is included, the entire transition declaration is invalid and will be ignored:

```
div {  
  ...  
  transition-property: color, border-width, border-color, border-  
    transform, opacity, box-shadow, width, padding;  
  transition-duration: 200ms, 180ms, 160ms, 140ms, 120ms, 100ms  
  transition-timing-function: ease, ease-in, ease-out, ease-in-  
    step-end, step-start, steps(5, start), steps(3, end);  
  transition-delay: 0s, 0.2s, 0.4s, 0.6s, 0.8s, 1s, 1.2s, 1.4s,  
}  
  
div {  
  ...  
  transition:  
    color 200ms,  
    border-width 180ms ease-in 200ms,  
    border-color 160ms ease-out 400ms,  
    border-radius 140ms ease-in-out 600ms,  
    transform 120ms linear 800ms,  
    opacity 100ms step-end 1s,  
    box-shadow 1s step-start 1.2s,  
    width 2s steps(5, start) 1.4s,  
    padding 3s steps(3, end) 1.6s;  
}
```

The two preceding CSS rule blocks are functionally equivalent: you can declare comma-separated values for the four longhand transition properties, or you can include a comma-separated list of single transitions. You can't, however, mix the two: `transition: transform, opacity 200ms ease-in 50ms` will ease in the opacity over 200 milliseconds after a 50-millisecond delay, but the `transform` change will be instantaneous, with no `transitionend` event.

Note the duration comes before the delay in all the single transitions. Also note the first single transition omits the delay and timing-function, as the

values they're mapped to in the longhand syntax version are the properties' default values.

# In Reverse: Transitioning Back to Baseline

In the preceding examples, we've declared a single transition. All our transitions have been applied in the default state and initiated with a `:hover`. With these declarations, the properties return back to the default state via the same transition on `mouseout`, with a reversing of the timing function and a duplication of the delay.

With transition declarations only in the global state, both the `hover` and `mouseout` states use the same `transition` declaration: the selector matches both states. We can override this duplication of the entire transition or just some of the transition properties by including different values for transition properties in the global (versus the `hover`-only) state.

When declaring transitions in multiple states, the transition included is *to* that state:

```
a {  
    background: yellow;  
    transition: 200ms background-color linear 0s;  
}  
a:hover {  
    background-color: orange;  
    /* delay when going <strong>to</strong> the :hover state */  
    transition-delay: 50ms;  
}
```

In this scenario, when the user hovers over a link, the background color waits 50 milliseconds before transitioning to orange. When the user mouses off the link, the background starts transitioning back to yellow immediately. In both directions, the transition takes 200 milliseconds to complete, and the gradual change proceeds in a linear manner. The 50 milliseconds is included in the `:hover` (orange) state. The delay happens, therefore, as the background



changes to orange.

In our drop-down menu example, on `:hover`, the menu appears and grows over 200 milliseconds, easing in after a delay of 50 milliseconds. The transition is set with the `transition` property in the default (nonhovered) state. When the user mouses out, the properties revert over 200 milliseconds, easing out after a delay of 50 milliseconds. This reverse effect is responding to the `transition` value from the non-hovered state. This is the default behavior, but it's something we can control. The best user experience is this default behavior, so you likely don't want to alter it—but it's important to know that you can.

If we want the closing of the menu to be jumpy and slow (we *don't* want to do that; it's bad user experience. But for the sake of this example, let's pretend we do), we can declare two different transitions:

```
nav ul ul {  
    transform: scale(1, 0);  
    opacity: 0;  
    ...  
    transition: all 4s steps(8, start) 1s;  
}  
nav li:hover ul {  
    transform: scale(1, 1);  
    opacity: 1;  
    transition: all 200ms linear 50ms;  
}
```

Transitions are to the *to* state: when there's a style change, the transition properties used to make the transition are the new values of the transition properties, not the old ones. We put the smooth, linear animation in the `:hover` state. The transition that applies is the one we are going toward. In the preceding example, when the user hovers over the drop-down menu's parent `li`, the opening of the drop-down menu will be gradual but quick, lasting 200 milliseconds after a delay of 50 milliseconds. When the user mouses off the drop-down menu or its parent `li`, the transition will wait one second and take

four seconds to complete, showing eight steps along the way.

When we only have one transition, we put it in the global *from* state, as you want the transition to occur toward any state, be that a hovering or a class change. Because we want the transition to occur with any change, we generally put the only transition declaration in the initial, default (least specific) block. If you do want to exert more control and provide for different effects depending on the direction of the transition, make sure to include a transition declaration in all of the possible class and UI states.

**Warning**

Beware of having transitions on both ancestors and descendants. Transitioning properties soon after making a change that transition ancestral or descendant nodes can have unexpected outcomes. If the transition on the descendant completes before the transition on the ancestor, the descendant will then resume inheriting the (still transitioning) value from its parent. This effect may not be what you expected.

# Animatable Properties and Values

Before implementing transitions and animations, it is important to understand what properties are transitional and animatable. You can transition (or animate) any animatable CSS properties; but which properties are animatable?

While we've included a list of these properties in "["Animatable Properties"](#)", CSS is evolving, and the [animatable properties list](#) will likely get new additions.<sup>6</sup>

*Interpolation* is the construction of data points between the values of known data points. The key guideline to determining if a property value is animatable is whether the *computed value* can be interpolated. If a property's keywords are computed values, they can't be interpolated; if its keywords compute to a number, they can be. The quick rule of thought is that if you can determine a midpoint between two property values, those property values are probably animatable. Values that are interpolatable are animatable. Those that aren't, aren't.

For example, the `display` values are nonnumeric keywords. Values like `block` and `inline-block` aren't numeric and therefore don't have a midpoint; they aren't animatable. The `transform` property values of `rotate(10deg)` and `rotate(20deg)` have a midpoint of `rotate(15deg)`; they are animatable.

The `border` property is shorthand for `border-style`, `border-width`, and `border-color` (which, in turn, are themselves shorthand properties for the four side values). While there is no midpoint between any of the `border-style` values, the `border-width` property length units are numeric, so they can be animated. The keyword values of `medium`, `thick`, and `thin` have numeric equivalents and are interpolatable: the computed value of the `border-width` property computes those keywords to lengths.

In the `border-color` value, colors are numeric—the named colors all represent hexadecimal color values—so colors are animatable as well. If you

transition from `border: red solid 3px` to `border: blue dashed 10px`, the border width and border colors will transition at the defined speed, but `border-style` will jump from `solid` to `dashed` as soon as the new value is applied.

`transitionend` events will occur for all the animatable properties. In this case, there will be eight `transitionend` events, for `border-top-width`, `border-right-width`, `border-bottom-width`, `border-left-width`, `border-top-color`, `border-right-color`, `border-bottom-color`, and `border-left-color`.

As noted (see [Table 10-3](#)), numeric values tend to be animatable. Keyword values that aren't translatable to numeric values generally aren't. CSS functions that take numeric values as parameters generally are animatable. One exception to this rule of thought is `visibility`: while there is no midpoint between the values of `visible` and `hidden`, `visibility` values are interpolatable between `visible` and `not-visible`. When it comes to the `visibility` property, either the initial value or the destination value must be `visible` or no interpolation can happen. The value will change at the end of the transition from `visible` to `hidden`. For a transition from `hidden` to `visible`, it changes at the start of the transition.

`auto` should generally be considered a nonanimatable value and should be avoided for animations and transitions. According to the specification, it is not an animatable value, but some browsers interpolate the current numeric value of `auto` (such as `height: auto`) to be 0px. `auto` is nonanimatable because it is a computed value for properties like `height`, `width`, `top`, `bottom`, `left`, `right`, and `margin`.

Often an alternative property or value may work. For example, instead of changing `height: 0` to `height: auto`, use `max-height: 0` to `max-height: 100vh`, which will generally create the expected effect. The `auto` value is animatable for `min-height` and `min-width`, since `min-height: auto` actually computes to 0.

# How Property Values Are Interpolated

Interpolation can happen when values falling between two or more known values can be determined. Interpolatable values can be transitioned and animated.

Numbers are interpolated as floating-point numbers. Integers are interpolated as whole numbers, incrementing or decrementing as whole numbers.

In CSS, length and percentage units are translated into real numbers. When transitioning or animating `calc()`, or from one type of length to or from a percentage, the values will be converted into a `calc()` function and interpolated as real numbers.

Colors, whether they are HSLA, RGB, or named colors, are interpolated into their RGBA equivalent values for transitioning.

When animating font weights, if you use keyterms like `bold`, they'll be converted to numeric values and animated in steps of multiples of 100. You may be used to writing `bold` and `normal`, but the values of 100 through 900 have been around as long as CSS—since CSS Level 1 in 1996.

When including animatable property values that have more than one component, each component is interpolated appropriately for that component. For example, `text-shadow` has up to four components: the color, `x`, `y`, and `blur`. The color is interpolated as `color`: the `x`, `y`, and `blur` components are interpolated as lengths. Box shadows have two additional optional properties: `inset` (or lack thereof) and `spread`. `spread`, being a length, is interpolated as such. The `inset` keyterm cannot be converted to a numeric equivalent: you can transition from one inset shadow to another inset shadow, or from one drop shadow to another drop shadow multi-component value, but there is no way to gradually transition between inset and drop shadows.

Similar to values with more than one component, gradients can be transitioned only if you are transitioning gradients of the same type (linear or radial) with equal numbers of color stops. The colors of each color stop are

then interpolated as colors, and the position of each color stop is interpolated as length and percentage units.

## Repeating values

When you have simple lists of other types of properties, each item in the list is interpolated appropriately for that type—as long as the lists have the same number of items or repeatable items, and each pair of values can be interpolated:

```
.img {  
    background-image:  
        url(1.gif), url(2.gif), url(3.gif), url(4.gif),  
        url(5.gif), url(6.gif), url(7.gif), url(8.gif),  
        url(9.gif), url(10.gif), url(11.gif), url(12.gif);  
    background-size: 10px 10px, 20px 20px, 30px 30px, 40px 40px;  
    transition: background-size 1s ease-in 0s;  
}  
.img:hover {  
    background-size: 25px 25px, 50px 50px, 75px 75px, 100px 100px  
}
```

For example, in transitioning four background-sizes, with all the sizes in both lists listed in pixels, the third `background-size` from the pretransitioned state can gradually transition to the third `background-size` of the transitioned list. In the preceding example, background images 1, 6, and 10 will transition from `10px` to `25px` in height and width when hovered. Similarly, images 3, 7, and 11 will transition from `30px` to `75px`, and so forth.

Remember, when there aren't enough declarations to match the number of background layers, the values are repeated. If there are too many values, the excess values are ignored. In this case, the `background-size` values are repeated three times, as if the CSS had been written as:

```
.img {  
    ...  
    background-size: 10px 10px, 20px 20px, 30px 30px, 40px 40px,  
                    10px 10px, 20px 20px, 30px 30px, 40px 40px,  
                    10px 10px, 20px 20px, 30px 30px, 40px 40px;  
    ...  
}
```

```
.img:hover {  
    background-size: 25px 25px, 50px 50px, 75px 75px, 100px 100px  
                25px 25px, 50px 50px, 75px 75px, 100px 100px  
                25px 25px, 50px 50px, 75px 75px, 100px 100px  
}
```

If a property doesn't have enough comma-separated values to match the number of background images, the list of values is repeated until there are enough, even when the list in the `:hover` state doesn't match the initial state:

```
.img:hover {  
    background-size: 33px 33px, 66px 66px, 99px 99px;  
}
```

If we transitioned from four `background-size` declarations in the initial state to three `background-size` declarations in the `:hover` state, all in pixels, still with 12 background images, the hover and initial state values are repeated (three and four times respectively) until we have the 12 necessary values, as if the following had been declared:

```
.img {  
    ...  
    background-size: 10px 10px, 20px 20px, 30px 30px,  
                    40px 40px, 10px 10px, 20px 20px,  
                    30px 30px, 40px 40px, 10px 10px,  
                    20px 20px, 30px 30px, 40px 40px;  
    ...  
}  
.img:hover {  
    background-size: 33px 33px, 66px 66px, 99px 99px,  
                    33px 33px, 66px 66px, 99px 99px,  
                    33px 33px, 66px 66px, 99px 99px,  
                    33px 33px, 66px 66px, 99px 99px;  
}
```

If a pair of values cannot be interpolated—for example, if the `background-size` changes from `contain` in the default state to `cover` when hovered—then, according to the specification, the lists are not interpolatable. However, some browsers ignore that particular pair of values for the purposes of the transition, but still animate the interpolatable values.

There are some property values that can animate if the browser can infer implicit values. For example, shadows. For shadows, the browser will infer

an implicit shadow `box-shadow: transparent 0 0 0` or `box-shadow: inset transparent 0 0 0`, replacing any values not explicitly included in the pre- or post-transition state. These examples are in the [chapter files for this book](#).

Only the interpolatable values lead to `transitionend` events.

As noted previously, `visibility` animates differently than other properties: if animating or transitioning to or from `visible`, it is interpolated as a discrete step. It is always visible during the transition or animation as long as the timing function output is between 0 and 1. It will switch at the beginning if the transition is from `hidden` to `visible`. It will switch at the end if the transition is from `visible` to `hidden`. Note that this can be controlled with the step timing functions.

# Animatable Properties

There is a list of animatable properties in the [CSS Transitions specification](#). This list only lists the CSS 2.1 properties that are transitional, so it is not wholly accurate.

[Table 10-3](#) shows a list of animatable properties and how their values are interpolated.

Table 10-3. Animatable properties

Property name	Interpolation
	<b>color</b>
color	as color
opacity	as number
	<b>columns</b>
column-width	as length
column-count	as integer
column-gap	as length
column-rule (see longhands)	
column-rule- color:	as color
column-rule- style:	no
column-rule- width:	as length
break-before	no
break-after	no
break-inside	no
column-span	no
column-fill	no
	<b>text</b>
hyphens	no

letter-spacing	as length
word-wrap	no
overflow-wrap	no
text-transform	no
tab-size	as length
text-align	no
text-align-last	no
text-indent	as length, percentage, or calc();
direction	no
white-space	no
word-break	no
word-spacing	as length
line-break	no

## Text decorations

text-decoration-color:	as color
text-decoration-style:	no
text-decoration-line:	no
text-decoration-skip	no
text-shadow	as shadow list
text-underline-position	no

## Flexible boxes

align-content	no
align-items	no
align-self	no
flex-basis	as length, percentage, or calc();
flex-direction	no
flex-flow	no
flex (see longhand)	

<code>flex-grow</code>	as number
<code>flex-shrink</code>	as number
<code>flex-basis:</code>	as length, percentage, or calc();
<code>flex-wrap</code>	no
<code>justify-content</code>	no
<code>order</code>	as integer

## Background and borders

<code>background</code>	
<code>background-color:</code>	as color
<code>background-image:</code>	no
<code>background-clip:</code>	no
<code>background-position:</code>	as list of length, percentage, or calc
<code>background-size:</code>	as list of length, percentage, or calc
<code>background-repeat:</code>	no
<code>background-attachment</code>	no
<code>background-origin</code>	no

## Borders

<code>border</code> (see longhand)	
<code>border-color</code>	as color
<code>border-style</code>	no
<code>border-width</code>	as length
<code>border-radius</code>	as length, percentage, or calc();
<code>border-image</code>	no (see longhand)
<code>border-image-outset</code>	no
<code>border-image-repeat</code>	no
<code>border-image-slice</code>	no

border-image-source	no
border-image-width	no
box-decoration-break	no
box-shadow	as shadow list
margin	as length
padding	as length
box-sizing	no
max-height	as length, percentage, or calc();
min-height	as length, percentage, or calc();
height	as length, percentage, or calc();
max-width	as length, percentage, or calc();
min-width	as length, percentage, or calc();
width	as length, percentage, or calc();
overflow	no
visibility	as visibility (see <a href="#">“How Property Values Are Interpolated”</a> )

## Table

border-collapse	no
border-spacing	no
caption-side	no
empty-cells	no
table-layout	no
vertical-align	as length

## Positioning

bottom	as length, percentage, or calc();
left	as length, percentage, or calc();
right	as length, percentage, or calc();
top	as length, percentage, or calc();
float	no

clear	no
position	no
z-index	as integer

## Fonts

font (see longhand)

font-style	no
font-variant	no
font-weight	as font weight
font-stretch	as font stretch
font-size	as length
line-height	as number, length
font-family	no
font-variant-ligatures	no
font-feature-settings	no
font-language-override	no
font-size-adjust	as number
font-synthesis	no
font-kerning	no
font-variant-position	no
font-variant-caps	no
font-variant-numeric	no
font-variant-east-asian	no
font-variant-alternates	no

## Images

object-fit	no
object-position	as length, percentage, or calc();
image-rendering	no

image-  
orientation no

## Counters, lists, and generated content

content no  
quotes no  
counter-  
increment no  
counter-reset no  
list-style no  
list-style-image no  
list-style-  
position no  
list-style-type no

## Page

orphans no  
page-break-after no  
page-break-  
before no  
page-break-  
inside no  
widows no

## User interface

outline (see  
longhand)  
outline-color as color  
outline-width as length  
outline-style no  
outline-offset as length  
cursor no  
resize no  
text-overflow no

## Animations

animation no (see longhands)  
animation-delay no

animation-direction	no
animation-duration	no
animation-fill-mode	no
animation-iteration-count	no
animation-name	no
animation-play-state	no
animation-timing-function	no, though animation-timing-function can be included in keyframes

## Transitions

transition	no (see longhands)
transition-delay	no
transition-duration	no
transition-property	no
transition-timing-function	no

## Transform properties

transform	as transform (see <a href="#">Transforms in CSS</a> [O'Reilly])
transform-origin	as length, percentage or calc();
transform-style	no
perspective	as length
perspective-origin	as simple list of a length, percentage or calc();
backface-visibility	no

## Compositing and blending

background-blend-mode	no
mix-blend-mode	no
isolation	no

## Shapes

shape-outside	yes, as basic-shape
shape-margin	as length, percentage, or calc();
shape-image-threshold	as number

## Miscellaneous

clip (deprecated)	as rectangle
display	no
unicode-bidi	no
text-orientation	no
ime-mode	no
all	as each of the properties of the shorthand (all properties but <code>unicode-bidi</code> and <code>direction</code> )
will-change	no
box-decoration-break	no
touch-action	no
initial-letter	no
initial-letter-align	no

# **transition Events Revisited**

The `transitionend` event fires when a transition completes.

The `transitionend` event has three properties. `propertyName` is the name of the CSS property whose transition completed, and `elapsedTime` is the number of seconds the transition had been running at the time the event fired, not including the transition delay. The third property is the `pseudoElement` property, which returns the name of the pseudo-element on which the transition occurred, either `::before` or `::after` (with two colons), or the empty string if the transition occurred on an element and not a pseudo-element.

Currently, the `transitionend` event will only occur if there is a positive, nonzero `transition-delay` or a nonzero `transition-duration`. The `transitionend` event only occurs if the sum of `transition-delay` (which can be negative) and `transition-duration` (which can't) is greater than zero. If there is no delay or no duration, there is no gradual transition, and no `transitionend` is fired, even if a property value has changed state.

You can use the `addEventListener()` method for the `transitionend` event to listen for this event.

If a keyframe animation, explained in the next chapter, is applied to a transitioning element, and it animates the same properties that are being transitioned, the animation takes precedence over the transition. Oddly, the `transitionend` event will still occur, but it will occur at the end of the animation.

## **Printing transitions**

When web pages or web applications are printed, the stylesheet for print media is used. If your style element's `media` attribute matches only `screen`, the CSS will not impact the printed page at all.

Often, no media attribute is included; it is as if `media="all"` were set, which is the default. Depending on the browser, when a transitioned element is printed, either the interpolating values are ignored, or the property values in their current state are printed.

You can't see the element transitioning on a piece of paper, but in some browsers, like Chrome, if an element transitioned from one state to another, the current state at the time the `print` function is called will be the value on the printed page, if that property is printable. For example, if a background color changed, neither the pre-transition or the post-transition background color will be printed, as background colors are generally not printed. However, if the text color mutated from one value to another, the current value of `color` will be what gets printed on a color printer or PDF.

In other browsers, like Firefox, whether the pre-transition or post-transition value is printed depends on how the transition was initiated. If it initiated with a hover, the non-hovered value will be printed, as you are no longer hovering over the element while you interact with the print dialog. If it transitioned with a class addition, the post-transition value will be printed, even if the transition hasn't completed. The printing acts as if the transition properties are ignored.

Given that there are separate printstyle sheets or `@media` rules for `print`, browsers compute style separately. In the `print` style, styles don't change, so there just aren't any transitions. The printing acts as if the property values changed instantly, instead of transitioning over time.

<sup>1</sup> Changing a background image may take longer than 16 milliseconds to decode and repaint to the page. This isn't a transition; it is just poor performance.

<sup>2</sup> There is a pending resolution in the CSS Working Group stating that nonanimatable properties should obey transitions. This will likely not be web-compatible and will probably be reverted.

<sup>3</sup> All of the examples in this chapter can be found at <http://standardista.com/transitions>.

<sup>4</sup> This might change. The CSS Working Group is considering making all property values animatable, switching from one value to the next at the midpoint of the timing function if there is no midpoint between the pre and post values.

<sup>5</sup> You can test the various transition-timing-function examples at <http://www.standardista.com/css3/transitions>.

<sup>6</sup> A proposed change to the specifications would make all properties transitional, even if they aren't in fact animatable. This has yet to be added to the specification, and I don't foresee it being implemented.

# Chapter 11. Animation

CSS transitions, covered in the previous chapter, enabled simple animations. With transitions, an element's properties change from the values set in one style block to the values set in a different style block as the element changes state over time instead of instantly. With CSS transitions, the start and end states of property values are controlled by existing property values and provide little control over how the property value interpolation progresses over time.

CSS animations are similar to transitions in that values of CSS properties change over time. But transitions only let us animate from an initial value to a destination value and back again. CSS keyframe animations let us decide if and how an animation repeats and give us granular control over what happens throughout the animation.

CSS animation lets us animate the values of CSS properties over time using keyframes. Similar to transitions, animation provides us with control over the delay and duration. With CSS animations, we can control the number of iterations, the iteration behavior, what happens before the first animation commences, and the state of animated properties after the last animation iteration concludes. CSS animation properties allow us to control timing and even pause an animation mid-stream.

While transitions trigger implicit property values changes, animations are explicitly executed when animation keyframe properties are applied.

With CSS animations, you can change property values that are not part of the set pre or post state of the element. The property values set on the animated element don't necessarily have to be part of the animation progression. For example, with transitions, going from black to white will only display varying shades of gray. With animation, that same element doesn't have to be black or white or even in-between shades of gray during the animation. While you *can* transition through shades of gray, you could instead turn the element yellow, then animate from yellow to orange. Alternatively, you could animate

through various colors, starting with black and ending with white, but



progressing through the entire rainbow <sup>1</sup> if you so choose. With animations, you can use as many keyframes as needed to granularly control an element's property values to create your desired effect.

The first step in implementing CSS animations is to create a *keyframe animation*—a reusable @keyframes at-rule defining which properties will be animated and how. The second step is to apply that keyframe animation to one or more elements in your document or application, using various animation properties to define how it will progress through the keyframes.

# Keyframes

To animate an element, we need to set the name of a keyframe animation; to do that, we need a named keyframe animation. Our first step is to define this reusable CSS keyframe animation using the `@keyframes` at-rule.

To define a CSS animation, we declare a reusable keyframe animation using the `@keyframes` rule, giving our animation a name. The name we create will then be used within a CSS selector's code block to attach this particular animation to the element(s) and/or pseudo-element(s) defined by the selector(s).

The `@keyframes` at-rule includes the animation identifier, or name, and one or more keyframe blocks. Each keyframe block includes one or more keyframe selectors with declaration blocks of zero or more property/value pairs. The entire `@keyframes` at-rule specifies the behavior of one full iteration of the animation. The animation may iterate zero or more times, depending mainly on the `animation-iteration-count` property value, which we'll discuss in ["The `animation-iteration-count` Property"](#).

The `@keyframes` at-rule keyterm is followed by the *animation\_identifier* (the name you give your animation for future reference), followed by curly braces that encompass the series of keyframe blocks.

Each keyframe block includes one or more keyframe selectors. The keyframe selectors are percentage-of-time positions along the duration of the animation; they are declared either as percentages or with the keyterms `from` or `to`:

```
@keyframes animation_identifier {  
    keyframe_selectorA {  
        property1: value1a;  
        property2: value2b;  
    }  
    keyframe_selectorB {  
        property1: value1b;  
        property2: value2b;  
    }  
}
```



# Setting Up Your Keyframe Animation

To create our keyframe animation, we start with the `@keyframes` at-rule keyterm, an animation name, and curly brackets to encompass the animation directives. Within the opening and closing curly brackets, we include a series of keyframe selectors with blocks of CSS in which we declare the properties we want to animate. The keyframes we declare don't in themselves animate anything. Rather, we must attach the keyframe animations we created via the `animation-name` property, whose value is the name or animation identifier we provided within our at-rule. We discuss that property in [“The `animation-name` Property”](#).

Start with the at-rule declaration, followed by the animation name and brackets:

```
@keyframes nameOfAnimation {  
  ...  
}
```

The name, which you create, is an identifier, not a string. Identifiers have specific rules. First, they can't be quoted. You can use any characters [a-zA-Z0-9], the hyphen (-), underscore (\_), and any ISO 10646 character U+00A0 and higher. ISO 10646 is the universal character set; this means you can use any character in the Unicode standard that matches the regular expression [-\_a-zA-Z0-9\u00A0-\u10FFFF].

There are some limitations on the name. As mentioned, do not quote the



animation identifier (or animation name).

The name can't start with a digit [0-9] or two hyphens. One hyphen is fine, as long as it is not followed by a digit—unless you escape the digit or hyphen with a backslash.

If you include any escape characters within your animation name, make sure to escape them with a backslash (\). For example, Q&A! must be written as Q\&A\!. œ can be left as œ (no, that's not a typo), and œ is a valid name as well. But if you are going to use any keyboard characters that aren't letters or digits, like !, @, #, \$, %, ^, &, \*, (, ), +, =, ~, \\", ., ', ", ;, :, [, ], {, }, |, \, or /, escape them with a backslash.

Also, don't use any of the keyterms covered in this chapter as the name of your animation. For example, possible values for the various animation properties we'll be covering later in the chapter include `none`, `paused`, `running`, `infinite`, `backwards`, and `forwards`, among others. Using an animation property keyterm, while not prohibited by the spec, will likely



break your animation when using the animation shorthand property discussed in [“The animation Shorthand Property”](#). So, while you can legally name your animation `paused` (or another keyterm,) I strongly recommend against it:

```
@keyframes bouncing {  
    ...  
}
```

After declaring the name of our `@keyframe` animation, in this case `bouncing`, we enclose all the rules of our at-rule in curly braces, as shown in the last code snippet. This is where we will put all our keyframes.

# Keyframe Selectors

Keyframe selectors provide points during our animation where we set the values of the properties we want to animate. In defining animations, we dictate the values we want properties to have at a specific percentage of the way through the animations. If you want a value at the start of the animation, you declare it at the 0% mark. If you want a different value at the end of the animation, you declare the property value at the 100% mark. If you want a value a third of the way through the animation, you declare it at the 33% mark. These marks are defined with keyframe selectors.

Keyframe selectors consist of a comma-separated list of one or more percentage values or the keywords `from` or `to`. The keyword `from` is equal to 0%. The keyword `to` equals 100%. The keyframe selectors are used to specify the percentage along the duration of the animation the keyframe represents. The keyframe itself is specified by the block of property values declared on the selector. The % unit must be used on percentage values: in other words, 0 is invalid as a keyframe selector:

```
@keyframes w {  
    from {  
        left: 0;  
        top: 0;  
    }  
    25%, 75% {  
        top: 100%;  
    }  
    50% {  
        top: 50%;  
    }  
    to {  
        left: 100%;  
        top: 0;  
    }  
}
```

This `@keyframes` animation, named `w`, when attached to a non-statically positioned element, would move that element along a W-shaped path. `w` has five keyframes, at the 0%, 25%, 50%, 75%, and 100% marks. The `from` is the



0% mark. The `to` is the 100% mark.

As the property values we set for the 25% and 75% mark are the same, we put two keyframe selectors together as a comma-separated list. Just as with regular CSS selectors, we can put multiple comma-separated keyframe selectors together in front of a single CSS block. Whether you keep those selectors on one line (as in the example) or put each selector on its own line is up to your own CSS style guidelines:

```
25%,  
75% {  
  top: 100%;  
}
```

Note that selectors do not need to be listed in ascending order. In the preceding example, we've placed the 25% and 75% on the same line, with the 50% mark coming after that declaration. For legibility, it is highly encouraged to progress from the 0% to the 100% mark. However, as demonstrated by the 75% keyframe in this example, which is "out of order," it is not required.

# Omitting `from` and `to` Values

If a `0%` or `from` keyframe is not specified, then the user agent (browser) constructs a `0%` keyframe using the original values of the properties being animated, as if the `0%` keyframe were declared with the same property values that impact the element when no animation was applied. Similarly, if the `100%` or `to` keyframe is not defined, the browser creates a faux `100%` keyframe using the value the element would have had if no animation had been set on it.

Assuming we have a `background-color` change animation:

```
@keyframes change_bgcolor {  
    45% { background-color: green; }  
    55% { background-color: blue; }  
}
```

And the element originally had `background-color: red` set on it, it would be



as if the animation were written as:

```
@keyframes change_bgcolor {  
    0% { background-color: red; }  
    45% { background-color: green; }  
    55% { background-color: blue; }  
    100% { background-color: red; }  
}
```

Or, remembering that we can include multiple identical keyframes as a comma-separated list, this faux animation could have also been written as:

```
@keyframes change_bgcolor {  
    0%,  
    100% { background-color: red; }  
    45% { background-color: green; }  
    55% { background-color: blue; }  
}
```

Note the `background-color: red;` declarations are not actually part of the keyframe animation. If the background color were set to yellow in the element's default state, the 0% and 100% marks would display a yellow background, animating into green, then blue, then back to yellow as the animation progressed:

```
@keyframes change_bgcolor {  
    0%, 100% { background-color: yellow; }  
    45% { background-color: green; }  
    55% { background-color: blue; }  
}
```

We can include this `change_bgcolor` animation on many elements, and the perceived animation will differ based on the element's value for the `background-color` property in the nonanimated state.

Negative percentages, values greater than 100%, and values that aren't otherwise percentages or the keyterms `to` or `from` are not valid and will be ignored. Noninteger percentage values, such as 33.33%, are valid.

# Repeating Keyframe Properties

In the original `-webkit-` implementation of animation, each keyframe could only be declared once: if declared more than once, only the last declaration would be applied, and the previous keyframe selector block was ignored. This has been updated. Now, similar to the rest of CSS, the values in the keyframe declaration blocks with identical keyframe values cascade. In the standard (nonprefixed) syntax, the preceding `w` animation can be written with the `to`, or `100%`, declared twice, overriding the value of the `left` property:

```
@keyframes W {  
  from, to {  
    top: 0;  
    left: 0;  
  }  
  25%, 75% {  
    top: 100%;  
  }  
  50% {  
    top: 50%;  
  }  
  to {  
    left: 100%;  
  }  
}
```

Note that in the preceding code block, `to` is declared along with `from` as keyframe selectors for the first code block. The `left` value is overridden for the `to` in the last keyframe block.

# Animatable Properties

Not all properties are animatable. Similar to the rest of CSS, the browser ignores properties and values in a keyframe declaration block that are not understood. Properties that are not animatable, with the exception of `animation-timing-function`, are also ignored. There is a fairly exhaustive list of animatable properties maintained by the community on the [Mozilla Developer Network](#) site.

## Note

The `animation-timing-function`, described in greater detail in “[The `animation-timing-function` Property](#)”, while not an animatable property, is not ignored. If you include the `animation-timing-function` as a keyframe style rule within a keyframe selector block, the timing function of the properties within that block will change to the declared timing function when the animation moves to the next keyframe.

You should not try to animate between nonnumeric values, with a few exceptions. For example, you can animate between nonnumeric values as long as they can be extrapolated into a numeric value, like named colors, which are extrapolated to hexadecimal color values.

If the animation is set between two property values that don't have a midpoint, the results may not be what you expect: the property will not animate correctly—or at all. For example, you shouldn't declare an element's height to animate between `height: auto` and `height: 300px`. There is no midpoint between `auto` and `300px`. The element may still animate, but different browsers handle this differently: Firefox does not animate the element; Safari may animate as if `auto` is equal to `0`; and both Opera and Chrome currently jump from the preanimated state to the postanimated state halfway through the animation, which may or may not be at the 50% keyframe selector, depending on the value of the `animation-timing-function`. In other words, different browsers behave differently for different properties when there is no midpoint, so you can't be sure you will get your expected

outcome.

The behavior of your animation will be most predictable if you declare both a



0% and a 100% value for every property you animate.

```
@keyframes round {  
    100% {  
        border-radius: 50%;  
    }  
}
```

For example, if you declare `border-radius: 50%`; in your animation, you may want to declare `border-radius: 0`; as well, because there is no midpoint between `none` and anything: the default value of `border-radius` is `none`, not `0`:

```
@keyframes square_to_round {  
    0% {  
        border-radius: 0%;  
    }  
    100% {  
        border-radius: 50%;  
    }  
}
```

The `round` animation will animate an element using the original `border-radius` value of that element to a `border-radius` of 50% over the duration of the animation cycle. The `round` animation may work as expected if you are turning rounded corner buttons into ovals (but it isn't likely to look good).

While including a 0% keyframe will ensure that your animation runs smoothly, the element may have had rounded corners to begin with. By adding `border-radius: 0%`; in the `from` keyframe, if the element was originally rounded, it will jump to rectangular corners before it starts animating. This might not be what you want. The best way to resolve this issue is to use the `round` animation instead of `square_to_round`, making sure any element that gets animated with the `round` keyframe animation has its



border-radius explicitly set.

As long as an animatable property is included in at least one block with a value that is different than the nonanimated attribute value, and there is a possible midpoint between those two values, that property will animate.

# Nonanimatable Properties That Aren't Ignored

Exceptions to the midpoint “rule” include `visibility` and `animation-timing-function`.

`visibility` is an animatable property, even though there is no midpoint between `visibility: hidden` and `visibility: visible`. When you animate from `hidden` to `visible`, the `visibility` value jumps from one value to the next at the keyframe upon which it is declared.

While the `animation-timing-function` is not, in fact, an animatable property, when included in a keyframe block, the animation timing will switch to the newly declared value at that point in the animation for the properties within that keyframe selector block. The change in animation timing is not animated; it simply switches to the new value.

# Dynamically Changing @keyframes Animations

There is an API that enables finding, appending, and deleting keyframe rules. You can change the content of a keyframe block within an `@keyframes` animation declaration with `appendRule(n)` or `deleteRule(n)`, where `n` is the full selector of that keyframe. You can return the contents of a keyframe with `findRule(n)`:

```
@keyframes W {  
  from, to {  
    top: 0;  
    left: 0;  
  }  
  25%, 75% {  
    top: 100%;  
  }  
  50% {  
    top: 50%;  
  }  
  to {  
    left: 100%;  
  }  
}
```

The `appendRule()`, `deleteRule()`, and `findRule()` methods takes the full keyframe selector as an argument. Revisiting the `w` animation, to return the 25% / 75% keyframe, the argument is `25%, 75%`:

```
// Get the selector and content block for a keyframe  
var aRule = myAnimation.findRule('25%, 75%').cssText;  
  
// Delete the 50% keyframe rule  
myAnimation.deleteRule('50%');  
  
// Add a 53% keyframe rules to the end of the animation  
myAnimation.appendRule('53% {top: 50%;}');
```

The statement `myAnimation.findRule('25%, 75%').cssText;` where `myAnimation` is pointing to a keyframe animation, returns the keyframe that

matches 25%, 75%. It would not match anything if we had used either 25% or 75% only. If pointing to the w animation, this statement returns 25%, 75% { top: 100%; }.

Similarly, myAnimation.deleteRule('50%') will delete the last 50% keyframe. deleteRule(n) deletes the last keyframe rule that has a keyframe selector n. To add a keyframe, myAnimation.appendRule('53% {top: 50%;}') will append a 53% keyframe after the last keyframe of the

@keyframes block.



# Animated Elements

Once you have created a keyframe animation, you need to apply that animation to elements and/or pseudo-elements for anything to actually animate. CSS animation provides us with numerous animation properties to attach a keyframe animation to an element and control its progression. At a minimum, we need to include the name of the animation for the element to animate, and a duration if we want the animation to actually be visible.

There are three animation events—`animationstart`, `animationend`, and `animationiteration`—that occur at the start and end of an animation, and between the end of an iteration and the start of a subsequent iteration. Any animation for which a valid keyframe rule is defined will generate the start and end events, even animations with empty keyframe rules. The `animationiteration` event only occurs when an animation has more than one iteration, as the `animationiteration` event does not fire if the `animationend` event would fire at the same time.

There are two ways of attaching animation properties to an element: you can include all the animation properties separately, or you can declare all the properties in one line using the `animation` shorthand property (or a combination of shorthand and longhand properties). We are going to first learn all the longhand properties. Later in this chapter, we'll condense all the declarations into one line with the `animation` shorthand property.

Let's start with the individual properties:

# The `animation-name` Property

The `animation-name` property takes as its value the name or comma-separated list of names of the keyframe animation you want to apply to an element or group of elements. The names are the unquoted identifiers you created in your `@keyframes` rule.

`animation-name`

**Values:**      `<@keyframes_identifier>` | `none` | `inherit` | `initial`

**Initial value:** `none`

**Applies to:** All elements, `::before` and `::after` pseudo-elements

**Inherited:** No

The default value is `none`, which means there is no animation. The `none` value can be used to override any animation applied elsewhere in the CSS cascade. (This is also the reason you don't want to name your animation `none`, unless you're a masochist.) To apply an animation, include the `@keyframe`



identifier, which is the animation name.

Using the `change_bgcolor` keyframe animation defined in “[Omitting from and to Values](#)”:

```
div {
```

```
        animation-name: change_bgcolor;  
    }
```

To apply more than one animation, include more than one comma-separated @keyframe identifier:

```
div {  
    animation-name: change_bgcolor, round, w;  
}
```

If one of the included keyframe identifiers does not exist, the series of animations will not fail: rather, the failed animation will be ignored, and the valid animations will be applied. While ignored initially, the failed animation will be applied if and when that identifier comes into existence as a valid animation:

```
div {  
    animation-name: change_bgcolor, spin, round, w;  
}
```

In this example, there is no `spin` keyframe animation defined. The `spin` animation will be ignored, while the `change_bgcolor`, `round`, and `w` animations are applied. Should a `spin` keyframe animation come into existence, it will be applied to the element at that time.

In order to include more than one animation, we've included each @keyframe animation identifier in our list of comma-separated values on the `animation-name` property. If more than one animation is applied to an element and those animations have repeated properties, the latter animations override the property values in the preceding animations. For example, if more than two background color changes are applied concurrently in two different keyframe animations, the latter animation will override the background property declarations of the preceding one, but only if the background colors were set to change at the same time. For more on this, see

[“Animation, Specificity, and Precedence Order”](#).



While not required, if you include three animation names, consider including three values for all the animation longhand property values, such as `animation-duration` and `animation-iteration-count`, so there are corresponding values for each attached animation. If there are too many values, the extra values are ignored. If there are too few comma-separated values, the provided values will be repeated. In other words, while it often makes sense to include the same number of values for each animation property as you do for the `animation-name` property, including fewer or more valid values will not invalidate the animations.

**Note**

If an included keyframe identifier doesn't exist, the animation doesn't fail. Any other animations attached via the `animation-name` property will proceed normally. If that nonexistent animation comes into existence, the animation will be attached to the element when the identifier becomes valid, and will start iterating immediately or after the expiration of any `animation-delay`.



See "["Setting Up Your Keyframe Animation"](#)".

This is true as long as the keyframe identifier for the nonexistent animation is a valid identifier. `change_bgcolor`, `spin`, `round`, `w` will work in spite of there being no `spin` animation, but `change_bgcolor`, `Q&A!`, `round`, `w` would fail, even if a `Q&A!` animation is declared, as `Q&A!` is not a valid identifier.

Simply applying an animation to an element is not enough for the element to visibly animate, but it will make the animation occur. The keyframe properties will be interpolated, and the `animationstart` and `animationend` events will fire. A single `animationstart` event occurs when the animation starts, and a single `animationend` event occurs when the animation ends, because the property-value interpolation occurs even if there was no perceptible animation.

For an element to visibly animate, the animation must last at least some

amount of time. For that we have the `animation-duration` property.

# The animation-duration Property

The `animation-duration` property defines how long a single animation iteration should take in seconds (`s`) or milliseconds (`ms`).

The `animation-duration` property takes as its value the length of time, in seconds (`s`) or milliseconds (`ms`), it should take to complete one cycle through all the keyframes. If omitted, the animation will still be applied with a duration of `0s`, with `animationstart` and `animationend` still being fired even though the animation, taking `0s`, is imperceptible. Negative values are invalid.

When including a duration, you must include the second (`s`) or millisecond (`ms`) unit:

```
div {  
    animation-name: change_bgcolor;  
    animation-duration: 200ms;  
}
```

**animation-duration**

**Values:**      `<time>`

**Initial value:** `0s`

**Applies to:** All elements, `::before` and `::after` pseudo-elements

**Inherited:** No

If you have more than one animation, you can include a different `animation-duration` for each animation by including more than one comma-separated

time duration:

```
div {  
    animation-name: change_bgcolor, round, W;  
    animation-duration: 200ms, 100ms, 0.5s;  
}
```

If you have an invalid value within your comma-separated list of durations, like `animation-duration: 200ms, 0, 0.5s`, the entire declaration will fail, and it will behave as if `animation-duration: 0s` had been declared. `0` is not



a valid time value.

Generally, you will want to include an `animation-duration` value for each `animation-name` provided. If you have only one duration, all the animations will last the same amount of time. Having fewer `animation-duration` values than `animation-name` values in your comma-separated property value list will not fail: rather, the values that are included will be repeated. If you have a greater number of `animation-duration` values than `animation-name` values, the extra values will be ignored. If one of the included animations does not exist, the series of animations and animation durations will not fail: the failed animation, along with its duration, are ignored:

```
div {  
    animation-name: change_bgcolor, spin, round, W;  
    animation-duration: 200ms, 5s, 100ms, 0.5s;  
}
```

In this example, the `5s`, or 5 seconds, is associated with `spin`. As there is no `spin @keyframes` declaration, `spin` doesn't exist, and the `5s` and `spin` are ignored. Should a spin animation come into existence, it will be applied to the `div` and last 5 seconds.

# The animation-iteration-count Property

Simply including the required `animation-name` will lead to the animation playing once. Include the `animation-iteration-count` property if you want to iterate through the animation more or less than the default one time.

`animation-iteration-count`

**Values:**      `<number>` | `infinite` | `initial`

**Initial value:** `1`

**Applies to:** All elements, `::before` and `::after` pseudo-elements

**Inherited:** No

By default, the animation will occur once. If `animation-iteration-count` is included, and there isn't a negative value for the `animation-delay` property, the animation will repeat the number of times specified by the value of the property, which can be any number or the keyterm `infinite`.

If the numeric value is not an integer, the animation will end partway through its last cycle. The animation will still run, but will cut off mid-animation on the final iteration. For example, `animation-iteration-count: 1.25` will iterate through the animation 1.25 times, cutting off 25% through the second iteration. If the value is `0.25` on an 8-second animation, the animation will play about 25% of the way through, ending after 2 seconds.

Negative numbers are not valid. Like any invalid value, a negative value will



lead to a default single iteration.

Interestingly, `0` is a valid value for the `animation-iteration-count` property. When set to `0`, the animation still occurs, but zero times. It is similar to setting `animation-duration: 0s`: it will throw both an `animationstart` and an `animationend` event.

If you are attaching more than one animation to an element or pseudo-element, include a comma-separated list of values for `animation-name`, `animation-duration`, and `animation-iteration-count`:

```
.flag {  
    animation-name: red, white, blue;  
    animation-duration: 2s, 4s, 6s;  
    animation-iteration-count: 3, 5;  
}
```

The `iteration-count` values (and all other animation property values) will be assigned in the order of the comma-separated `animation-name` property value. Extra values will be ignored. Missing values will cause the existing values to be repeated. Invalid values will invalidate the entire declaration.

In the preceding example, there are more name values than count values, so the count values will repeat: `red` and `blue` will iterate three times, and `white` will iterate five times. There are the same number of name values as duration values; therefore, the duration values will not repeat. The `red` animation lasts two seconds, iterating three times, and therefore will run for six seconds. The `white` animation lasts four seconds, iterating five times, for a total of 20 seconds. The `blue` animation is six seconds per iteration with the repeated three iterations value, animating for a total of 18 seconds.

If we wanted all three animations to end at the same time, even though their durations differ, we can control that with `animation-iteration-count`:

```
.flag {  
    animation-name: red, white, blue;
```

```
    animation-duration: 2s, 4s, 6s;  
    animation-iteration-count: 6, 3, 2;  
}
```

In that example, the `red`, `white`, and `blue` animations will last for a total of 12 seconds each: `red` animates over 2 seconds, iterating 6 times, for a total of 12 seconds; `white` lasts 4 seconds, iterating 3 times, for a total of 12 seconds; and `blue` lasts 6 seconds, iterating 2 times, for a total of 12 seconds. With simple arithmetic, you can figure out how many iterations you need to make one effect last as long as another, remembering that the `animation-iteration-count` value doesn't need to be an integer.

# The animation-direction Property

With the `animation-direction` property, you can control whether the animation progresses from the 0% keyframe to the 100% keyframe, or from the 100% keyframe to the 0% keyframe. You can control whether all the iterations progress in the same direction, or set every other animation cycle to progress in the opposite direction.

**animation-direction**

**Values:**      `normal` | `reverse` | `alternate` | `alternate-reverse`

**Initial value:** `normal`

**Applies to:** All elements, `::before` and `::after` pseudo-elements

**Inherited:** No

The `animation-direction` property defines the direction of the animation's progression through the keyframes. There are four possible values:

`animation-direction: normal`

When set to `normal` (or omitted, which defaults to `normal`), each iteration of the animation progresses from the 0% keyframe to the 100% keyframe.

`animation-direction: reverse`

The `reverse` value sets each iteration to play in reverse keyframe order, always progressing from the 100% keyframe to the 0% keyframe.

Reversing the animation direction also reverses the `animation-timing-function`. This property is described in “[The `animation-timing-function` Property](#)”.

```
animation-direction: alternate
```

The `alternate` value means the first iteration (and each subsequent odd-numbered iteration) should proceed from 0% to 100%, and the second iteration (and each subsequent even-numbered cycle) should reverse direction, proceeding from 100% to 0%.

```
animation-direction: alternate-reverse
```

The `alternate-reverse` value is similar to the `alternate` value, except the odd-numbered iterations are in the reverse direction, and the even-numbered animation iterations are in the normal direction. `alternate-reverse` alternates the direction of each iteration, beginning with `reverse`. The first iteration (and each subsequent odd numbered iteration) proceeds from 100% to 0%; the second iteration (and each subsequent even-numbered cycle) reverses direction, going from 100% to 0%:

```
.ball {
    animation-name: bouncing;
    animation-duration: 400ms;
    animation-iteration-count: infinite;
    animation-direction: alternate-reverse;
}
@keyframes bouncing {
    from {
        transforms: translateY(500px);
    }
    to {
        transforms: translateY(0);
    }
}
```

In this example, we are bouncing our ball, but we want to start by dropping it, not by throwing it up in the air: we want it to alternate between going down and up, rather than up and down, so `animation-direction: alternate-`



`reverse` is the most appropriate value for our needs.

This is a very rudimentary way of making a ball bounce. When balls are bouncing, they are moving slowest when they reach their apex and fastest when they reach their nadir. We included this example here to illustrate the alternate-reverse animation directions. We'll revisit the bouncing animation again later to make it more realistic with the addition of timing (see “[The `animation-timing-function` Property](#)”). There we will also discuss how, when the animation is iterating in the reverse direction, the `animation-timing-function` is reversed.

# The `animation-delay` Property

The `animation-delay` property defines how long the browser waits after the animation is attached to the element before beginning the first animation iteration. The default value is `0s`, meaning the animation will commence immediately when it is applied. A positive value will delay the start of the animation until the prescribed time, listed as the value of the `animation-delay` property has elapsed. A negative value will cause the animation to begin immediately—but it will start partway through the animation.

The `animation-delay` property sets the time, defined in seconds (`s`) or milliseconds (`ms`), that the animation will wait between when the animation is attached to the element and when the animation begins executing. By default, the animation begins iterating as soon as it is applied to the element, with a 0-second delay.

## **animation-delay**

**Values:**      `<time>`

**Initial value:** `0s`

**Applies to:** All elements, `::before` and `::after` pseudo-elements

**Inherited:** No

Unlike `animation-duration`, a negative value for the `animation-delay` property is valid. Negative values for `animation-delay` can create interesting effects. A negative delay will execute the animation immediately but will begin animating the element part way through the attached animation. For

example, if `animation-delay: -4s` and `animation-duration: 10s` are set on an element, the animation will begin immediately but will start approximately 40% of the way through the first animation.

I say “approximately” because it will not necessarily start at the 40% keyframe block: when the 40% mark of an animation occurs depends on the value of the `animation-timing-function`. If `animation-timing-function: linear` is set, then it will be 40% through the animation, at the 40% keyframe, if there is one:

```
div {  
  animation-name: move;  
  animation-duration: 10s;  
  animation-delay: -4s;  
  animation-timing-function: linear;  
}  
  
@keyframes move {  
  from {  
    transform: translateX(0);  
  }  
  to {  
    transform: translateX(1000px);  
  }  
}
```

In this `linear` animation example, we have a 10-second animation with a 4-second delay. In this case, the animation will start immediately 40% of the way through the animation, with the `div` translated 400 pixels to the right of



its original position.

If an animation is set to occur 10 times, with a delay of -800 milliseconds and an animation duration of 200 milliseconds, the element will start animating right away, at the beginning of the fifth iteration:

```
.ball {  
  animation-name: bounce;  
  animation-duration: 200ms;
```

```

        animation-delay: -600ms;
        animation-iteration-count: 10;
        animation-timing-function: ease-in;
        animation-direction: alternate;
    }
@keyframes bounce {
    from {
        transform: translateY(0);
    }
    to {
        transform: translateY(500px);
    }
}

```

Instead of animating for 2,000 milliseconds ( $200\text{ ms} \times 10 = 2,000\text{ ms}$ ), or 2 seconds, starting in the normal direction, the ball will animate for 1,400 milliseconds with the animation starting immediately—but at the start of the fourth iteration, and in the reverse direction. The `animation-direction` is set to alternate, meaning every even iteration iterates in the reverse direction from the 100% keyframe to the 0% keyframe. The fourth iteration, which is



an even-numbered iteration, is the first visible iteration.

The animation will throw the `animationstart` event immediately. The `animationend` event will occur at the 1,400-millisecond mark. The ball will be tossed up, rather than bounced, throwing 6 `animationiteration` events, after 200, 400, 600, 800, 1,000, and 1,200 milliseconds. While the iteration count was set to 10, we only get 6 `animationiteration` events because we are only getting 7 iterations; 3 iterations didn't occur because of the negative `animation-delay`, and the last iteration concluded at the same time as the `animationend` event. Remember, when an `animationiteration` event would occur at the same time as an `animationend` event, the `animationiteration` event does not occur.

Let's take a deeper look at animation events before continuing.

# Animation Events

There are three different types of animation events: `animationstart`, `animationiteration`, and `animationend`. For browsers still prefixing animations, these events are supported when written as `webkitAnimationStart`, `webkitAnimationIteration`, and `webkitAnimationEnd`. Each event has three read-only properties of `animationName`, `elapsedTime`, and `pseudoElement`, unprefixed in all browsers.

The `animationstart` event occurs at the start of the animation: after the `animation-delay` (if present) has expired, or immediately if there is no delay set. If a negative `animation-delay` value is present, the `animationstart` will fire immediately, with an `elapsedTime` equal to the absolute value of the delay in supporting browsers. In browsers where prefixing is still necessary, the `elapsedTime` is 0:

```
.noAnimationEnd {  
    animation-name: myAnimation;  
    animation-duration: 1s;  
    animation-iteration-count: infinite;  
}  
  
.startAndEndSimultaneously {  
    animation-name: myAnimation;  
    animation-duration: 0s;  
    animation-iteration-count: infinite;  
}
```

The `animationend` event occurs when the animation finishes. If the `animation-iteration-count` is set to `infinite` as long as the `animation-duration` is set to a time greater than 0, the event will never fire. If the `animation-duration` is set or defaults to 0 seconds, even when the iteration count is `infinite` `animationstart` and `animationend` will occur virtually simultaneously, in that order.

The `animationiteration` event fires *between* iterations. The `animationend`



event fires at the conclusion of iterations that do not occur at the same time as the conclusion of the animation itself; the `animationiteration` and `animationend` events do not fire simultaneously:

```
.noAnimationIteration {  
    animation-name: myAnimation;  
    animation-duration: 1s;  
    animation-iteration-count: 1;  
}
```

In the `.noAnimationIteration` example, with the `animation-iteration-count` set to a single occurrence, the animation ends at the conclusion of the first and only iteration. When the `animationiteration` event would occur at the same time as an `animationend`, the `animationend` event occurs, but the `animationiteration` event does not. The `animationiteration` does not fire unless an animation cycle ends and another begins.

When the `animation-iteration-count` property is omitted, or when its value is 1 or less, no `animationiteration` event will be fired. As long as an iteration finishes (even if it's a partial iteration) and the next iteration begins, if the duration is greater than 0s, an `animationiteration` event will occur.

If the `animation-iteration-count` is omitted, or has an invalid value, it defaults to `animation-iteration-count: 1`. Because the `animationiteration` event does not fire if it would occur at the same time as the `animationend`, the `animationiteration` event will not occur when `animation-iteration-count` is omitted, even though a full cycle of the animation may occur:

```
.noAnimationIteration {  
    animation-name: myAnimation;  
    animation-duration: 1s;  
    animation-iteration-count: 4;  
    animation-delay: -3s;  
}
```

When an animation iterates through fewer cycles than listed in the

animation-iteration-count because of a negative animation-delay, there are no animationiteration events for the non-occurring cycles. In the preceding example code, there are no animationstart events, as the first three cycles do not occur (due to the -3s animation-delay), and the



last cycle finishes at the same time the animation ends.

In that example, the elapsedTime on the animationstart event is 3, as it is equal to the absolute value of the delay. This is supported in browsers that can handle unprefixed animations.

## Animation chaining

You can use animation-delay to chain animations together so the next animation starts immediately after the conclusion of the preceding animation:

```
.rainbow {  
    animation-name: red, orange, yellow, blue, green;  
    animation-duration: 1s, 3s, 5s, 7s, 11s;  
    animation-delay: 3s, 4s, 7s, 12s, 19s;  
}
```

In this example, the red animation starts after a three-second delay and lasts one second, meaning the animationend event occurs at the four-second mark. This example starts each subsequent animation at the conclusion of the



previous animation. This is known as *animation chaining*.

By including a four-second delay on the second animation, the orange animation will begin interpolating the @keyframe property values at the four-second mark, starting the orange animation immediately at the conclusion of the red animation. The orange animation concludes at the seven-second mark—it lasts 3 seconds, starting after a four-second delay—which is the

delay set on the third, or `yellow`, animation, making the `yellow` animation begin immediately after the `orange` animation ends.

This is an example of chaining animations on a single element. You can also use the `animation-delay` property to chain the animations for different elements:

```
li:first-of-type {  
    animation-name: red;  
    animation-duration: 1s;  
    animation-delay: 3s;  
}  
li:nth-of-type(2) {  
    animation-name: orange;  
    animation-duration: 3s;  
    animation-delay: 4s;  
}  
li:nth-of-type(3) {  
    animation-name: yellow;  
    animation-duration: 5s;  
    animation-delay: 7s;  
}  
li:nth-of-type(4) {  
    animation-name: green;  
    animation-duration: 7s;  
    animation-delay: 12s;  
}  
li:nth-of-type(5) {  
    animation-name: blue;  
    animation-duration: 11s;  
    animation-delay: 19s;  
}
```



If you want a group of list items to animate in order, appearing as if the animations were chained in sequence, the `animation-delay` of each list item should be the combined time of the `animation-duration` and `animation-delay` of the previous animation.

The `animation-delay` property is an appropriate method of using CSS

animation properties to chain animations. There is one caveat: animations are the lowest priority on the UI thread. Therefore, if you have a script running that is occupying the user interface (or UI) thread, depending on the browser and which properties are being animated and what property values are set on the element, the browser may let the delays expire while waiting until the UI thread is available before starting the animations.

**Note**

Some, but not all, animations in all browsers take place on the UI thread. In most browsers, when opacity or transforms are being animated, the animation takes place on the GPU, instead of the CPU, and doesn't rely on the UI thread's availability. If those properties are not part of the animation, the unavailability of the UI thread can lead to jank. Changing the opacity, transforming, or putting an element in 3D space puts the element in its own independent layer to be drawn by the graphics processor, using GPU instead of CPU and the potentially blocked UI thread.

```
/* Don't do this */
* {
    transform: translateZ(0);
}
```

On devices and browsers that support 3D animation, putting an element into 3D space moves that element into its own layer, allowing for jank-free animations. For this reason, the `translateZ` hack—the thing I just told you not to do—became overused. While putting a few elements onto their own layers with this hack is OK, some devices have limited video memory. Each independent layer you create uses video memory and takes time to move from the UI thread to the composited layer on the GPU. The more layers you create, the higher the performance cost.

Edge, Chrome, Opera, and Safari can all be optimized this way. Firefox currently can't. It's likely that additional animatable properties will be animated on the GPU on composite layers off-thread in the near future.

For improved performance, whenever possible, include `transform` and `opacity` in your animations over `top`, `left`, `bottom`, `right`, and `visibility`.

Not only does it improve performance by using the GPU over the CPU, but when you change box-model properties, the browser needs to reflow and repaint, which is bad for performance. Just don't put everything on the GPU, or you'll find different performance issues.

In the preceding scenario in a nonperformant browser, if it took 11 seconds for the browser to download, parse, and execute the document's JavaScript, the animation delay for the first 3 list items will expire before the UI thread is able to animate the properties. In this case, the first three animations—red, orange, and yellow—will begin simultaneously when the JavaScript finishes executing, with the fourth animation—green—starting a second later, before the orange and yellow animations have finished animating. In this scenario, only the last animation—blue—would start as designed: when the previous animation ended.

For this reason, you may want to attach animations to elements based on an ancestor class that gets added when the document is ready, with JavaScript.

If you are able to rely on JavaScript, another way of chaining animations is listening for `animationend` events to start subsequent animations:



```
document.querySelectorAll('li')[0].addEventListener( 'animationend',
  function(e) {
    document.querySelectorAll('li')[1].style.animationName = 'o
  },
  false );

document.querySelectorAll('li')[1].addEventListener( 'animationend',
  function(e) {
    document.querySelectorAll('li')[2].style.animationName = 'y
  },
  false );

document.querySelectorAll('li')[2].addEventListener( 'animationend',
  function(e) {
    document.querySelectorAll('li')[3].style.animationName = 'g
  },
```

```
false );

document.querySelectorAll('li')[3].addEventListener( 'animationend',
  function(e) {
    document.querySelectorAll('li')[4].style.animationName = 'b
  },
  false );

li:first-of-type {
  animation-name: red;
  animation-duration: 1s;
}
li:nth-of-type(2) {
  animation-duration: 3s;
}
li:nth-of-type(3)  {
  animation-duration: 5s;
}
li:nth-of-type(4) {
  animation-duration: 7s;
}
li:nth-of-type(5)  {
  animation-duration: 11s;
}
```

In this example, there is an event handler on each of the first four list items listening for that list item's `animationend` event. When the `animationend` event occurs, the event listeners add an `animation-name` to the subsequent list item.

This animation chaining method doesn't employ `animation-delay`. Instead of using this CSS property, it employs JavaScript event listeners to attach animations to the element by setting the `animation-name` property when the `animationend` event is thrown.

In our CSS snippet, you'll note that the `animation-name` was only included for the first list item. The other list items only have an `animation-duration`—with no `animation-name`, and therefore no attached animations. Adding `animation-name` is what attaches and starts the animation. To start or restart an animation, the animation name or identifier must be removed and then added back—at which point all the animation properties take effect, including `animation-delay`.

Instead of writing:

```
document.querySelectorAll('li')[2].addEventListener( 'animationen
  function(e) {
    document.querySelectorAll('li')[3].style.animationName = 'g
  },
  false );

document.querySelectorAll('li')[3].addEventListener( 'animationen
  function(e) {
    document.querySelectorAll('li')[4].style.animationName = 'b
  },
  false );

li:nth-of-type(4) {
  animation-duration: 7s;
}
li:nth-of-type(5) {
  animation-duration: 11s;
}
```

we could have also written:

```
document.querySelectorAll('li')[2].addEventListener( 'animationen
  function(e) {
    document.querySelectorAll('li')[3].style.animationName = 'g
    document.querySelectorAll('li')[4].style.animationName = 'b
  },
  false );

li:nth-of-type(4) {
  animation-duration: 7s;
}
li:nth-of-type(5) {
  animation-delay: 7s;
  animation-duration: 11s;
}
```

When we added the `blue` animation name to the fifth list item with JavaScript at the same time we added `green`, the delay on the fifth element took effect at that point in time and started expiring.

**Note**

While changing the values of animation properties (other than name) on the element during an animation has no effect on the animation, removing or adding an `animation-name` does have an impact. You can't change the animation duration from `100ms` to `400ms` in the middle of an animation. You can't switch the delay from `-200ms` to `5s` once the delay has already been applied. You can, however, stop and start the animation by removing it and reapplying it. In this JavaScript example, we started the animations by applying them to the elements.

In addition, setting `display: none` on an element terminates the animation. Updating the display back to a visible value restarts the animation from the beginning. If there is a positive value for `animation-delay`, the delay will have to expire before the `animationstart` event happens and any animations occur. If the delay is negative, the animation will start midway through an iteration, exactly as it would have if the animation had been applied any other way.

## Animation iteration delay

While there is no such property as an `animation-iteration-delay`, you can employ the `animation-delay` property, incorporate delays within your keyframe declaration, or use JavaScript to fake it. The best method for faking it depends on the number of iterations, performance, and whether the delays are all equal in length.

What is an animation iteration delay? Sometimes you want an animation to occur multiple times, but want to wait a specific amount of time between each iteration.

Let's say you want your element to grow three times, but want to wait four seconds between each one-second iteration. You can include the delay within your keyframe definition and iterate through it three times:

```
.animate3times {  
  background-color: red;  
  animation: color_and_scale_after_delay;  
  animation-iteration-count: 3;  
  animation-duration: 5s;
```

```

}

@keyframes color_and_scale_after_delay {
    80% {
        transform: scale(1);
        background-color: red;
    }
    80.1% {
        background-color: green;
        transform: scale(0.5);
    }
    100% {
        background-color: yellow;
        transform: scale(1.5);
    }
}

```

Note the first keyframe selector is at the 80% mark and matches the default



state. This will animate your element three times: it stays in the default state for 80% of the five-second animation (or four seconds) and then moves from green to yellow and small to big over the last one second of the animation before iterating again, stopping after three iterations.

This method works for any number of iterations of the animation. Unfortunately, it is only a good solution if the delay between each iteration is identical and you don't want to reuse the animation with any other timing,



such as a delay of six seconds. If you want to change the delay between each iteration while not changing the duration of the change in size and color, you have to write a new `@keyframes` definition.

To enable different iteration delays between animations, we could create a single animation and bake in the effect of three different delays:

```
.animate3times {
```

```

background-color: red;
animation: color_and_scale_3_times;
animation-iteration-count: 1;
animation-duration: 15s;
}

@keyframes color_and_scale_3_times {
  0%, 13.32%, 20.01%, 40%, 46.67%, 93.32% {
    transform: scale(1);
    background-color: red;
  }
  13.33%, 40.01%, 93.33% {
    background-color: green;
    transform: scale(0.5);
  }
  20%, 46.66%, 100% {
    background-color: yellow;
    transform: scale(1.5);
  }
}
}

```



This method may be more difficult to code and maintain. It works for a single cycle of the animation. To change the number of animations or the iteration delay durations, another `@keyframes` declaration would be required. This example is even less robust than the previous one, but it does allow for different between-iteration delays.

There's a solution that currently works in most browsers that is not specifically allowed in the animation specification, but it isn't disallowed—it's not currently supported in Edge, but hopefully it will be. The solution is to declare an animation multiple times, each with a different `animation-`



`delay` value:

```
.animate3times {
  animation: color_and_scale, color_and_scale, color_and_scale;
```

```

        animation-delay: 0, 4s, 10s;
        animation-duration: 1s;
    }

@keyframes color_and_scale {
    0% {
        background-color: green;
        transform: scale(0.5);
    }
    100% {
        background-color: yellow;
        transform: scale(1.5);
    }
}

```

We've attached the animation three times, each with a different delay. In this case, each animation iteration concludes before the next one proceeds.

If animations overlap while they're concurrently animating, the values will be the values from the last declared animation. As is true whenever there are multiple animations changing an element's property at the same time, the animation that occurs last in the sequence of animation names will override any animations occurring before it in the list of names. In declaring three `color_and_scale` animations but at different intervals, the value of the property of the last iteration of the `color_and_scale` animation will override



the values of the previous ones that haven't yet concluded.

The safest, most robust and most cross-browser-friendly method of faking an `animation-iteration-delay` property is to use animation events. On `animationend`, detach the animation from the element, then reattach it after the iteration delay. If all the iteration delays are the same, you can use `setInterval`; if they vary, use `setTimeout`:

```

var iteration = 0;
var el = document.getElementById('myElement');

el.addEventListener('animationend', function(e) {
    var time = ++iteration * 1000;

```

```
el.classList.remove('animationClass');

setTimeout(function() {
  el.classList.add('animationClass');
}, time);

});
```

This example animates `myElement` infinitely, adding an additional second



between each iteration of the animation.

# The animation-timing-function Property

Similar to the `transition-timing-function` property, the `animation-timing-function` property describes how the animation will progress over one cycle of its duration, or iteration.

## **animation-timing-function**

**Values:** `ease | linear | ease-in | ease-out | ease-in-out | step-start | step-end | steps(<integer>, start) | steps(<integer>, end) | cubic-bezier(<number>, <number>, <number>, <number>)`

**Initial value:** `ease`

**Applies to:** All elements, `::before` and `::after` pseudo-elements

**Inherited:** No

Other than the step timing functions, described in “[The step timing functions](#)”, the timing functions are all Bézier curves. Just like the `transition-timing-function`, the CSS specification provides for five predefined Bézier curve keyterms, as shown in [Figure 11-1](#) and [Table 11-1](#).



**Figure 11-1. Cubic Bézier named functions**

Table 11-1. Bézier curve keyterms

Timing function	Cubic Bézier value
ease	cubic-bezier(0.25, 0.1, 0.25, 1)
linear	cubic-bezier(0, 0, 1, 1)
ease-in	cubic-bezier(0.42, 0, 1, 1)
ease-out	cubic-bezier(0, 0, 0.58, 1)
ease-in-out	cubic-bezier(0.42, 0, 0.58, 1)

A handy tool to visualize Bézier curves and to create your own is Lea Verou's [cubic Bézier visualizer](#).

The default `ease` is equal to `cubic-bezier(0.25, 0.1, 0.25, 1)`, which has a slow start, then speeds up, and ends slowly. This function is similar to `ease-in-out` at `cubic-bezier(0.42, 0, 0.58, 1)`, which has a greater acceleration at the beginning. `linear` is equal to `cubic-bezier(0, 0, 1, 1)`, and, as the name describes, creates an animation that animates at a constant speed.

`ease-in` is equal to `cubic-bezier(0.42, 0, 1, 1)`, which creates an animation that is slow to start, gains speed, then stops abruptly. The opposite

`ease-out` timing function is equal to `cubic-bezier(0, 0, 0.58, 1)`, starting at full speed, then slowing progressively as it reaches the conclusion of the animation iteration.

If none of these work for you, you can create your own Bézier curve timing function by passing four values, such as:

```
animation-timing-function: cubic-bezier(0.2, 0.4, 0.6, 0.8);
```

Bézier curves are mathematically defined parametric curves used in two-dimensional graphic applications. See [Table 10-3](#) for examples of curves you can define yourself in CSS.

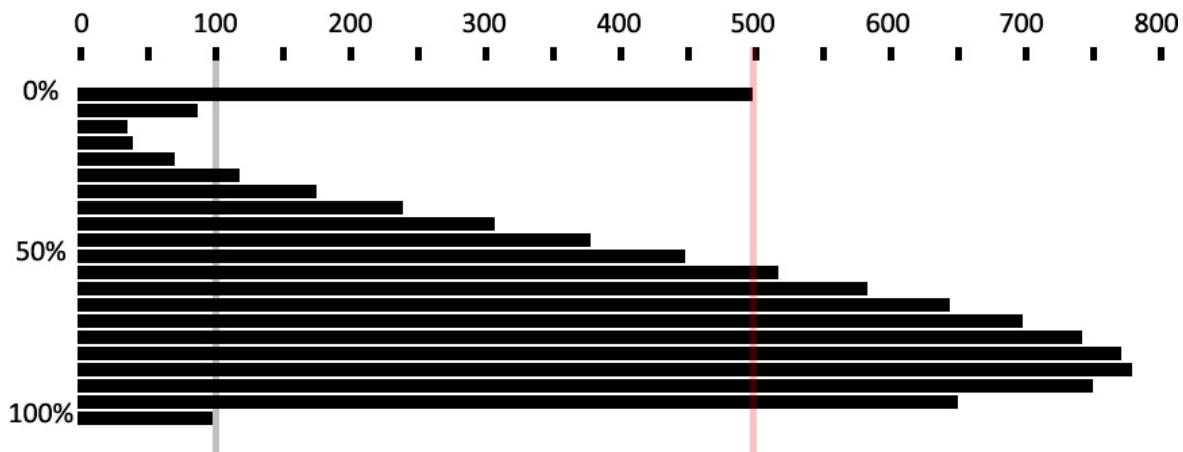
The Bézier curve takes four values, defining the originating position of the two handles. In CSS, the anchors are at 0, 0 and 1, 1. The first two values define the x and y of the first point or handle of the curve, and the last two are the x and y of the second handle of the curve. The x values must be between 0 and 1, or the Bézier curve is invalid. When creating your own Bézier curve, remember: the steeper the curve, the faster the motion. The flatter the curve, the slower the motion.

While the x values must be between 0 and 1, by using values for y that are greater than 1 or less than 0, you can create a bouncing effect, making the animation bounce up and down between values, rather than going consistently in a single direction:

```
.snake {
    animation-name: shrink;
    animation-duration: 10s;
    animation-timing-function: cubic-bezier(0, 4, 1, -4);
    animation-fill-mode: both;
}

@keyframes shrink {
    0% {
        width: 500px;
    }
    100% {
        width: 100px;
    }
}
```

This `animation-timing-function` value makes the property values go outside the boundaries of the values set in the 0% and 100% keyframes. In this example, we are shrinking an element from 500px to 100px. However, because of the `cubic-bezier` values, the element we're shrinking will actually grow to be wider than the 500px width defined in the 0% keyframe and narrower than the 100px width defined in the 100% keyframe, as shown in [Figure 11-2](#).



**Figure 11-2. Effect of outlandish Bézier curve**

In this scenario, with `animation-timing-function: cubic-bezier(0, 4, 1, -4);` set on an animation that is shrinking an element from 500px wide, the snake starts with a width of 500px, defined in the 0% keyframe. It then quickly shrinks down to a width of about 40px, which is narrower than `width: 100px;` (which was declared in the 100% keyframe) before slowly expanding to about 750px wide, which is larger than the original width of `width: 500px` declared as the original (and widest) declared width. It then quickly shrinks back down to `width: 100px`, which is the value defined in the 100% keyframe. You can test this and your own cubic Bézier



values.

You may have realized that the curve created by our animation is the same curve as our Bézier curve. Just like our s-curve goes below and above our

bounding box, the width of our animation goes narrower than the smaller width we set of `100px` and wider than the larger width we set of `500px`.

The Bézier curve has the appearance of a snake, going up and down and up again, because one y coordinate is positive and the other negative. If both are positive values greater than 1 or both are negative values less than -1, the Bézier curve is arc-shaped, going above or below one of the values set, but not bouncing out of bounds on both ends like the s-curve above.

The timing function declared for the `animation-timing-function` is the timing for the normal animation direction, when the animation is progressing from the `0%` mark to the `100%` mark. When the animation is running in the reverse direction, from the `100%` mark to the `0%` mark, the animation timing function is reversed:

```
.ball {  
    animation-name: bounce;  
    animation-duration: 1s;  
    animation-iteration-count: infinite;  
    animation-timing-function: ease-in;  
    animation-direction: alternate;  
}  
  
@keyframes bounce {  
    0% {  
        transform: translateY(0);  
    }  
    100% {  
        transform: translateY(500px);  
    }  
}
```



If we remember the bouncing ball example, when the ball is dropping it gets faster as it nears its nadir at the `100%` keyframe, with the `animation-timing-function` set to `ease-in`. When it is bouncing up, it is animating in the reverse direction, from `100%` to `0%`, so the `animation-timing-function` is reversed as well, to `ease-out`, slowing down as it reaches its apex. Our original defaulted to `ease`. This timing function makes

the bouncing ball look a bit more realistic.

## The step timing functions

The step timing functions, `step-start`, `step-end`, and `steps()`, aren't Bézier curves. Rather, they're *tweening* definitions.

The `steps()` timing function divides the animation into a series of equal-length steps. `steps()` takes two parameters: the number of steps and the direction.

The `steps()` function is most useful when it comes to character or sprite animation. If you want to animate complex shapes that subtly change, like the drawings or pictures in a flip book, the `steps()` timing function is the solution.

The number of steps is the first parameter; its value must be a positive integer. The animation will be divided equally into the number of steps provided. For example, if the animation duration is 1 second and the number of steps is 5, the animation will be divided into five 200-millisecond steps, with the element being redrawn to the page 5 times, at 200-millisecond intervals, moving 20% through the animation at each interval.

If an animation were to pass through 5 steps, that means it either draws the animation at the 0%, 20%, 40%, 60%, and 80% keyframes or at the 20%, 40%, 60%, 80%, and 100% keyframes. It will either skip drawing the 100% or the 0% keyframe. That is where the *direction* parameter comes in.

The *direction* parameter takes one of two values: either `start` or `end`. The direction determines if the function is left- or right-continuous: basically, if the 0% or the 100% keyframe is going to be skipped. Including `start` as the second parameter will create a left-continuous function, meaning the first step happens when the animation begins, skipping the 0%, but including the 100%. Including `end` or omitting the second parameter (`end` is the default direction) will create a right-continuous function. This mean the first step will be at the 0% mark, and the last step will be before the 100% mark. With `end`, the 100% keyframe will not be seen unless `animation-fill-mode` of either

forwards or both is set. See [“The animation-fill-mode Property”](#).

The direction parameter can be hard to remember. I like to think of it this way: the *start* value *skips* the start value of 0%, and the *end* value *skips* the ending value of the 100% keyframe.

The `step-start` value is equal to `steps(1, start)`, with only a single step displaying the 100% keyframe. The `step-end` value is equal to `steps(1, end)`, which displays only the 0% keyframe.

Consider the flip book. A flip book is a book with a series of pictures. Each page contains a single drawing or picture that changes slightly from one page to the next, like one frame from a movie reel or cartoon stamped onto each page. When the pages of a flip book are flipped through rapidly (hence the name), the pictures appear as an animated motion. You can create similar animations with CSS using an image sprite, the `background-position` property, and the `steps()` timing function.

[Figure 11-3](#) shows an image sprite containing several images that change just slightly, like the drawings on the individual pages of our flip book.



**Figure 11-3. Sprite of dancing**

We put all of our slightly differing images into a single image called a *sprite*. Each image in our sprite is a frame in the single animated image we’re creating.

We create a container element that is the size of a single image of our sprite and attach the sprite as the container element’s background image. We then animate the `background-position`, using the `steps()` timing function so we only see a single instance of the changing image of our sprite at a time. The number of steps in our `steps()` timing function is the number of occurrences of the image in our sprite. The number of steps defines how many stops our background image makes to complete a single animation.

The sprite in [Figure 11-3](#) has 22 images, each 56 x 100 pixels. The total size of our sprite is 1232 x 100 pixels. We set our container to the individual image size: 56 x 100 pixels. We set our sprite as our background image: the initial or default value of `background-position` is `top left`, which is the same as `0 0`. Our image will appear at `0 0`, which is a good default: older browsers that don't support CSS animation will simply display the first image from our sprite:

```
.dancer {  
    height: 100px;  
    width: 56px;  
    background-image: url(..../images/dancer.png);  
    ...  
}
```

The trick is to use `steps()` to change the `background-position` value so that each frame is a view of a separate image within the sprite. Instead of sliding in the background image from the left, the `steps()` timing function will pop in the background image in the number of steps we declared.

We declare our animation to simply be a change in the left-right value of the `background-position`. The image is 1,232 pixels wide, so we move the background image from `0 0`, which is the left top, to `0 -1232px`, putting the sprite fully outside of our 56 x 100 pixel `<div>` viewport.

The values of `-1232px 0` will move the image completely to the left, outside of our containing block viewport. It will no longer show up as a background image in our 100 x 56 pixel `div` at the 100% mark unless `background-repeat` is set to repeat along the x-axis. We don't want that to happen!

With the `steps(n, end)` syntax, the 100% keyframe never gets shown as the animation runs. Had we used `start` instead of `end`, the 0% keyframe wouldn't show. With `end`, the 100% keyframe is skipped instead. Because we used `end`, the 100% keyframe—when the background image is outside of the border box of our element—doesn't show. This is what we want:

```
@keyframes dance_in_place {  
    from {  
        background-position: 0 0;  
    }  
}
```

```

        to {
            background-position: -1232px 0;
        }
    }

.dancer {
    ....
    background-image: url(..../images/dancer.png);
    animation-name: dance_in_place;
    animation-duration: 4s;
    animation-timing-function: steps(22, end);
    animation-iteration-count: infinite;
}

```

We used `steps(22, end)`. We use the `end` direction to show the 0% keyframe, but not the 100% keyframe. What may have seemed like a complex animation is very simple: just like a flip book, we see one frame of the sprite at a time. Our keyframe animation simply moves the background.



## Adding a second animation

Our dancer is dancing in place. Most dancers move around when they dance. We can add a little left-and-right and back-and-forth motion by adding a second animation:

```

@keyframes move_around {
    0%, 100% {
        transform: translate(0, -40px) scale(0.9);
    }
    25% {
        transform: translate(40px, 0) scale(1);
    }
    50% {
        transform: translate(0, 40px) scale(1.1);
    }
    75% {
        transform: translate(-40px, 0) scale(1);
    }
}

```

```
}
```

We create a second keyframe animation called `move_around` and attach it to our dancer element as a second animation with comma-separated animation



property declarations:

```
.dancer {  
    ...  
    background-image: url(..../images/dancer.png);  
    animation-name: dance_in_place, move_around;  
    animation-duration: 4s, 16s;  
    animation-timing-function: steps(22, end), steps(5, end);  
    animation-iteration-count: infinite;  
}
```

Note that each animation property has two comma-separated values except `animation-iteration-count`. If you recall, if an animation property doesn't have enough comma-separated values to match the number of animations declared by the `animation-name` property, the values present will be repeated until there are enough. We want both animations to continue indefinitely. As the value of `infinite` is for all the attached animations, we only need a single value for that property. The browser will repeat the list of `animation-iteration-count` values—in this case, just the single value of `infinite`—until it has matched an `animation-iteration-count` value for each animation declared.

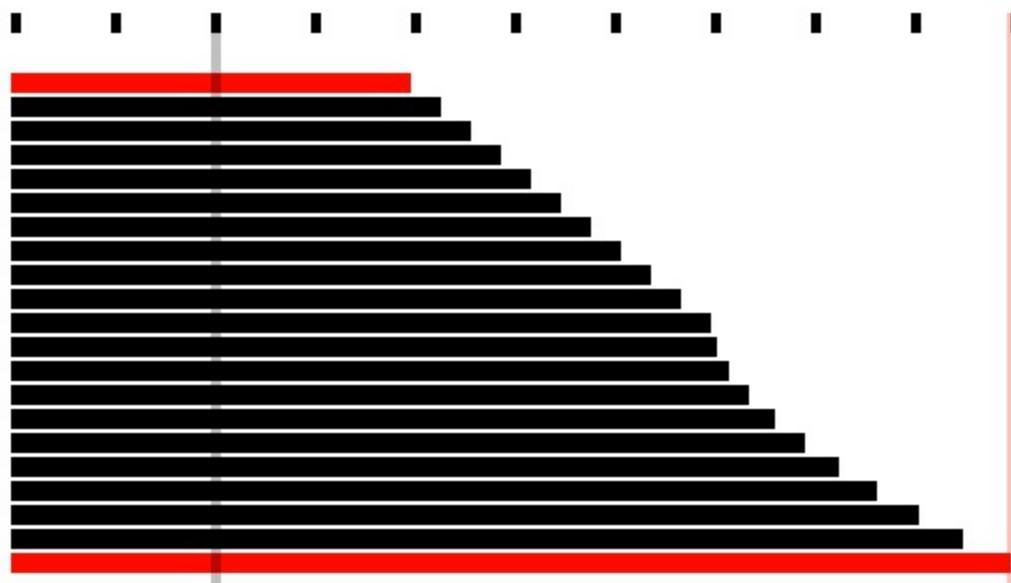
## Animating the `animation-timing-function`

The `animation-timing-function` is not an animatable property, but it can be included in a keyframe to alter the current timing of the animation.

When included within a keyframe, the `animation-timing-function` doesn't transition from one value to another over time. Rather, the timing function applies between keyframes, updating the timing function when it reaches a keyframe that has a timing function defined.

While none of the animation properties are animatable, `animation-timing-function` is the only CSS animation property that has an effect when specified on individual keyframes. Unlike animatable properties, the `animation-timing-function` values aren't interpolated over time. When included in a keyframe within the `@keyframes` definition, the timing function for the properties declared within that same keyframe will change to the new `animation-timing-function` value when that keyframe is reached, as shown in [Figure 11-4](#):

```
@keyframes width {  
  0% {  
    width: 200px;  
    animation-timing-function: linear;  
  }  
  50% {  
    width: 350px;  
    animation-timing-function: ease-in;  
  }  
  100% {  
    width: 500px;  
  }  
}
```



**Figure 11-4.** Animation timing function can be changed midanimation

In other words, the rate at which the animation proceeds can be altered mid

animation. In the preceding example, as shown in [Figure 11-4](#), halfway through the animation, we switch from a linear animation progression for the



`width` property to one that eases in.

We can include the `animation-timing-function` within our keyframe animation definitions to override this default inverting behavior or to control the timing in any other way we please. The `animation-timing-function` property isn't animated in the sense of changing from one value to another over time. Rather, it changes from one value to the next when it reaches a keyframe selector that declares a change to that value.

Specifying the `animation-timing-function` within the `to` or `100%` keyframe will have no effect on the animation. When included in the `from` or `0%` keyframe, the animation will follow the `animation-timing-function` specified in the keyframe definition, overriding the element's default or declared `animation-timing-function`.

#### Note

The specification states explicitly the timing function should only impact the progression of an animation if it is declared in any keyframe other than the `to` or `100%` keyframe values. An `animation-timing-function` declaration in the `100%` or `to` keyframe has no effect, as per current implementations and the specification.

If the `animation-timing-function` property is included in a keyframe, only the properties also included in that keyframe block will have their timing function impacted. This is not currently specified in the CSS specification, but it is implemented as such and is expected to be included in the final specification. If we take our `w` animation as an example:

```
@keyframes w {  
  from {  
    left: 0;  
    top: 0;
```

```

        }
        25%, 75% {
            top: 100%;
        }
        50% {
            top: 50%;
        }
        to {
            left: 100%;
            top: 0;
        }
    }
}

```

This follows the idea that conceptually, when an animation is set on an element or pseudo-element, it is as if a set of keyframes is created for each property that is present in any of the keyframes, as if an animation is run independently for each property that is being animated. It's as if the `w` animation were made up of two animations that run simultaneously: `w_part1` and `w_part2`.

```

@keyframes w_part1 {
    from, to {
        top: 0;
    }
    25%, 75% {
        top: 100%;
    }
    50% {
        top: 50%;
    }
}

@keyframes w_part2 {
    from {
        left: 0;
    }
    to {
        left: 100%;
    }
}

```

The `animation-timing-function` that is set on any of the keyframes is added to the progression of only the properties that are defined at that keyframe:

```

@keyframes W {
  from {
    left: 0;
    top: 0;
  }
  25%, 75% {
    top: 100%;
  }
  50% {
    animation-timing-function: ease-in;
    top: 50%;
  }
  to {
    left: 100%;
    top: 0;
  }
}

```

You can have multiple occurrences of a keyframe value, such as 50%, as the current implementation stands, but the `animation-timing-function` and `property` have to be in the same selector block for the `animation-timing-function` change to have an impact. The preceding code will change the `animation-timing-function` to `ease-in` for the `top` property only, not the `left` property, impacting only the `w_part1` section of our `w` animation.

However, with the following animation, the `animation-timing-function` (in a keyframe block that has no property/value declarations) will have no effect:

```

@keyframes W {
  from {
    left: 0;
    top: 0;
  }
  25%, 75% {
    top: 100%;
  }
  50% {
    animation-timing-function: ease-in;
  }
  50% {
    top: 50%;
  }
  to {
    left: 100%;
    top: 0;
  }
}

```

```
    }
}
```

How is it useful to change the timing function midanimation? In the bounce animation, we had a frictionless environment: the ball bounced forever, never losing momentum. We had a very simple animation that iterated forever. The `ease-in` timing function made it speed up as it dropped, when it was in the normal animation direction. We took advantage of timing functions being inverted in the reverse animation direction: in this case, as if it was set to `ease-out` in the reverse direction. With our infinite animation, the ball sped up as it dropped and slowed as it rose because the timing function was inverted from `ease-in` to `ease-out` by default as the animation proceeded from the normal to reverse direction every other iteration.

In reality, friction exists; momentum is lost. Balls will not continue to bounce indefinitely. If we want our bouncing ball to look natural, we have to make it bounce less high as it loses energy with each impact. To do this, we need a single animation that bounces multiple times, losing momentum on each bounce, while switching between `ease-in` and `ease-out` at each apex and nadir:

```
@keyframes bounce {
  0% {
    transform: translateY(0);
    animation-timing-function: ease-in;
  }
  30% {
    transform: translateY(100px);
    animation-timing-function: ease-in;
  }
  58% {
    transform: translateY(200px);
    animation-timing-function: ease-in;
  }
  80% {
    transform: translateY(300px);
    animation-timing-function: ease-in;
  }
  95% {
    transform: translateY(360px);
    animation-timing-function: ease-in;
  }
  15%, 45%, 71%, 89%, 100% {
```

```
    transform: translateY(380px);  
    animation-timing-function: ease-out;  
}  
}
```

This animation loses height after a few bounces, eventually stopping.



This more realistic animation has a single iteration, with the granular control provided via the keyframe blocks.

In the case of a single iteration, we can't rely on the `animation-direction` to change our timing function. We need to ensure that while each bounce causes the ball to lose momentum, it still speeds up with gravity and slows down as it reaches its apex. Because we will have only a single iteration, we control the timing by including `animation-timing-function` within our keyframes. At every apex, we switch to `ease-in`, and at every nadir, or bounce, we switch to `ease-out`.

# The animation-play-state property

The `animation-play-state` property defines whether the animation is running or paused.

`animation-play-state`

**Values:** `running` | `paused`

**Initial value:** `running`

**Applies to:** All elements, `::before` and `::after` pseudo-elements

**Inherited:** No

When set to the default `running`, the animation proceeds as normal. If set to `paused`, the animation will be paused. When `paused`, the animation is still applied to the element, halted at the progress it had made before being paused. When set back to `running` or returned to the default of `running`, it restarts from where it left off, as if the “clock” that controls the animation had stopped and started again.

If the property is set to `animation-play-state: paused` during the delay phase of the animation, the delay clock is also paused and resumes expiring



as soon as `animation-play-state` is set back to `running`.

# The `animation-fill-mode` Property

The `animation-fill-mode` property defines what values are applied by the animation before and after the animation iterations are executed. The `animation-fill-mode` property enables us to define whether or not an element's property values are applied by the animation outside of the animation execution. The duration of the animation execution is set by the number of iterations multiplied by the duration, less the absolute value of any negative delay.

With `animation-fill-mode`, we can define how the animation impacts the element on which it is set before the `animationstart` and after the `animationend` events are fired. We can define whether the property values set in the 0% keyframe are applied to the element during the expiration of any animation delay, and if the property values that exist when the `animationend` event is fired continue to be applied to the animated element after the animation's conclusion, or if the properties revert to the values they had in their initial state prior to the attachment of the animation.

By default, an animation will not affect the property values of the element immediately if there is a positive `animation-delay` applied. Rather, animation property values are applied when the `animation-delay` expires, when the `animationstart` event is fired. By default, the animation property values are applied until the last iteration has completed: at the completion of the animation, when the `animationend` event is fired. At that time, the element's property values revert back to its nonanimated values.

The `animation-fill-mode` property lets us apply the property values of any `from` or 0% keyframes to an element from the time the animation is applied to that element until the expiration of the animation delay. It also enables us to maintain the property values of the 100% or `to` keyframe after the last animation cycle is complete, from the time the `animationend` event has fired until forever—or until the animation is removed from the element.

`animation-fill-mode`

**Values:** none | forwards | backwards | both

**Initial value:** none

**Applies to:** All elements, ::before and ::after pseudo-elements

**Inherited:** No

The default value is `none`, which means the animation has no effect when it is not executing: the animation's 0% keyframe block property values are not applied to the animated element until the `animation-delay` has expired, when the `animationstart` event is fired.

When the value is set to `backwards`, the property values from the 0% or `from` keyframe (if there is one) will be applied to the element as soon as the animation is applied to the element. The 0% keyframe property values are applied immediately (or 100% keyframe, if the value of the `animation-direction` property is `reversed` or `reversed-alternate`), without waiting for the `animation-delay` time to expire, before the `animationstart` event fires.

The value of `forwards` means when the animation is done executing—has concluded the last part of the last iteration as defined by the `animation-iteration-count` value—it continues to apply the values of the properties at the values as they were when the `animationend` event occurred. If the `iteration-count` has an integer value, this will be either the 100% keyframe, or, if the last iteration was in the reverse direction, the 0% keyframe.

The value of `both` applies both the `backwards` effect of applying the property values when the animation is attached to the element and the `forwards` value of persisting the property values from when the `animationend` event occurred.

If the `animation-iteration-count` is a float value, and not an integer, the last iteration will not end on the 0% or 100% keyframe: the animation will end its execution partway through an animation cycle. If the `animation-fill-mode` was set forwards or both, the element will maintain the property values it had when the `animationend` event occurred. For example, if the `animation-iteration-count` is 6.5, and the `animation-timing-function` is linear, the `animationend` event fires and the values of the properties at the 50% mark (whether or not a 50% keyframe is explicitly declared) will stick, as if the `animation-play-state` had been set to `pause` at that point.

For example, if we take the following code:

```
@keyframes move_me {
  0% {
    transform: translateX(0);
  }
  100% {
    transform: translateX(1000px);
  }
}

.moved {
  animation-name: move_me;
  animation-duration: 10s;
  animation-timing-function: linear;
  animation-iteration-count: 0.6;
  animation-fill-mode: forwards;
}
```

The animation will only go through 0.6 iterations. Being a linear 10-second animation, it will stop at the 60% mark 6 seconds into the animation, when the element is translated 600 pixels to the right. With `animation-fill-mode` set to `forwards` or `both`, the animation will stop animating when it is translated 600 pixels to the right, holding the moved element 600 pixels to the right of its original position, keeping it translated indefinitely, or until the animation is detached from the element.

In Safari 9 and earlier, `forwards` and `both` will set the values from the 100% keyframe onto the element, no matter the direction of the last iteration or whether the animation otherwise ended on the 100% keyframe or elsewhere



in the animation.

In the preceding example, in Safari 9, the `.moved` element will jump from being translated by 400 pixels to the right to be 1,000 pixels to the right of where it normally would have been and stay there indefinitely or until the animation is detached from the moved element. In Safari 9 and earlier, it doesn't matter whether the last iteration was `normal` or `reverse`, or whether the animation ended 25% or 75% of the way through an animation cycle; `animation-fill-mode: forwards;` causes the animation to jump to the 100% frame and stay there. This follows an older version of the specification, but we expect it will be updated to match the updated specification and all other evergreen browsers.

The `backwards` value controls what happens to the element from the time the animation is attached to the element until the time the animation delay expires, the animation starts executing, and the `animationstart` event is fired. Before the animation starts executing (during the period specified by a positive `animation-delay` value), the animation applies the values it will have when the animation starts executing. If the `animation-direction` is `normal` or `alternate`, the values specified in the animation's 0% keyframe are applied immediately when the animation is attached. If the `animation-direction` is `reverse` or `alternate-reverse`, the property values of the 100% keyframe are used.

The value of `both` simply means that both the `forwards` and `backwards` fill modes will be applied. Most times when you set an animation, you will set the `animation-fill-mode` property to `both`. This ensures that the animated element's properties don't jump from the element's default state to the animated state at the start of execution, and that the element's properties don't jump back to its original property values at the animation's end. Having properties jump from one value to another before or after a smooth animation is generally the opposite of what you're trying to do.

With `both`, as soon as the animation is attached to an element, that element will assume the properties provided in the 0% keyframe (or 100% keyframe if `animation-direction` is set to `reverse` or `alternate-reverse`). When the

last iteration concludes, it will be as if the `animation-fill-mode` were set to `forwards`: if it was a full iteration in the normal direction, the property values of the 100% keyframe will be applied. If the last cycle was in the reverse direction, the property values of the 0% keyframe will be applied. With `forwards` and `both`, whether or not the last iteration was a full iteration, the values that were present when the `animationend` event occurred will stay in



effect.

If the `animation-duration` is set to `0s` and `backward` or `both` is set, the animation will stay on the 0% keyframe (or 100% keyframe if `animation-direction` is set to `reverse` or `reverse-alternate`) until the animation delay has expired. With no duration, it will immediately jump to the 100%



keyframe (or the 0% keyframe if `animation-direction` is set to `reverse` or `reverse-alternate`). If `both` or `forwards` is set, it will stay on that final keyframe in perpetuity or until the animation is removed from the element or generated content. This happens no matter the value of the `animation-iteration-count`, even if the count is 0. In that case, the `animationstart` and `animationend` events will occur in succession at the expiration of the delay, and there will be no `animationiteration` event.

If the 0% or 100% keyframes are not explicitly defined, the browser uses the implied values for those keyframes: the values set forth on the element itself. If an keyframe animation has neither a 0% or 100% keyframe set, setting `animation-fill-mode: backwards` will have no impact. Similarly, in the case where the `animation-iteration-count` is an integer and no 0% or 100% keyframe is set, setting `animation-fill-mode` to `forwards` or `both` has no impact. If the iteration count is a float, even if there are no `to` or `from` keyframes, if there is an intermediary keyframe block with property values set, `forwards`, `backwards`, and `both` should have an impact, other than in Safari ≤9.

# The animation Shorthand Property

The `animation` shorthand property enables us to use one line instead of eight to define all the animation properties on an element. The `animation` property value is a list of space-separated values for the various longhand animation properties. If you are setting multiple animations on an element or pseudo-element, include the multiple space-separated animation shorthands as a comma-separated list of animations.

## **animation**

none | <series of individual animation properties>  
<animation-duration> || <animation-timing-function> ||  
**Values:** <animation-delay> || <animation-iteration-count> ||  
<animation-direction> || <animation-fill-mode> ||  
<animation-play-state> || <animation-name>

**Initial value:** 0s ease 0s 1 normal none running none

**Applies to:** All elements, `::before` and `::after` pseudo-elements

**Inherited:** No

The `animation` shorthand takes as its value all the other preceding animation properties, including `animation-duration`, `animation-timing-function`, `animation-delay`, `animation-iteration-count`, `animation-direction`, `animation-fill-mode`, `animation-play-state`, and `animation-name`:

```
#animated {  
    animation: 200ms ease-in 50ms 1 normal running forwards slidedo  
}
```

is the equivalent of:

```
#animated {  
    animation-name: slidedown;  
    animation-duration: 200ms;  
    animation-timing-function: ease-in;  
    animation-delay: 50ms;  
    animation-iteration-count: 1;  
    animation-fill-mode: forwards;  
    animation-direction: normal;  
    animation-play-state: running;  
}
```

or:

```
#animated {  
    animation: 200ms ease-in 50ms forwards slidedown;  
}
```

We didn't have to declare all of the values in the animation shorthand; any values that aren't declared are set to the default or initial values. The first shorthand line was long and three of the properties were set to default, so were not necessary.

It's important to remember that if you don't declare all eight values in your shorthand declaration, the ones you don't declare will get the initial value for that property. The initial or default values are:

```
animation-name: none;  
animation-duration: 0s;  
animation-timing-function: ease;  
animation-delay: 0;  
animation-iteration-count: 1;  
animation-fill-mode: none;  
animation-direction: normal;  
animation-play-state: running;
```

The order of the shorthand is partially important. For example, there are two time properties: the first is always the duration. The second, if present, is

interpreted as the delay.

While the order of all properties that make up a shorthand are important, the order of numeric values with the same unit type are always important, no matter the property. For example, in the `flex` shorthand, the first unitless number is the `flex-grow` value; the second is the `flex-shrink` factor. Similarly, for the `animation` shorthand, the first time value is always the `animation-duration`. The second, if present, is always the `animation-delay`.

The placement of the `animation-name` can also be important. If you use an `animation` property value as your animation identifier (which you shouldn't), the `animation-name` should be placed as the *last* property value in the `animation` shorthand. The first occurrence of a keyword that is a valid value for any of the other animation properties, such as `ease` or `running`, will be assumed to be part of the shorthand of the `animation` property the keyword is associated with rather than the `animation-name`. Note that `none` is basically the only word that is not a valid animation name:

```
#failedAnimation {  
    animation: paused 2s;  
}
```

This is the equivalent to:

```
#failedAnimation {  
    animation-name: none;  
    animation-duration: 2s;  
    animation-delay: 0;  
    animation-timing-function: ease;  
    animation-iteration-count: 1;  
    animation-fill-mode: none;  
    animation-direction: normal;  
    animation-play-state: paused;  
}
```

`paused` is a valid animation name. While it may seem that the animation named `paused` with a duration of `2s` is being attached to the element, that is not what is happening. Because words within the shorthand `animation` are first checked against possible valid values of all `animation` properties other than `animation-name` first, `paused` is being set as the value of the

`animation-play-state` property.

```
#anotherFailedAnimation {  
    animation: running 2s ease-in-out forwards;  
}
```

The preceding code snippet is the equivalent to:

```
#anotherFailedAnimation {  
    animation-name: none;  
    animation-duration: 2s;  
    animation-delay: 0s;  
    animation-timing-function: ease-in-out;  
    animation-iteration-count: 1;  
    animation-fill-mode: forwards;  
    animation-direction: normal;  
    animation-play-state: running;  
}
```

The developer probably has a keyframe animation called `running`. The browser, however, sees the term and assigns it to the `animation-play-state` property rather than the `animation-name` property. With no `animation-name` declared, there is no animation attached to the element.

In light of this, `animation: 2s 3s 4s;` may seem valid, as if the following were being set:

```
#invalidName {  
    animation-name: 4s;  
    animation-duration: 2s;  
    animation-delay: 3s;  
}
```

But as we remember from “[Setting Up Your Keyframe Animation](#)”, `4s` is *not* a valid identifier. Identifiers cannot start with a digit unless escaped. For this animation to be valid, it would have to be written as `animation: 2s 3s \34s;`

To attach multiple animations to a single element or pseudo-element, comma-separate the animation declarations:

```
.snowflake {  
    animation: 3s ease-in 200ms 32 forwards falling,
```

```
    1.5s linear 200ms 64 spinning;  
}
```

Our snowflake will fall while spinning for 96 seconds, spinning twice during



each 3-second fall. At the end of the last animation cycle, the snowflake will stay fixed on the 100% keyframe of the `falling` @keyframes animation. We declared six of the eight animation properties for the `falling` animation and five for the spinning animation, separating the two animations with a comma.

While you'll most often see the animation name as the first value—it's easier to read that way, because of the issue with animation property keywords being valid keyframe identifiers—it is not a best practice. That is why we put the animation name at the end.

It is fine, even a good idea, to use the animation shorthand. Just remember that the placement of the duration, delay, and name within that shorthand are important, and omitted values will be set to their default values. Also, it is a good idea to not use any animation keyterms as your identifier.

# Animation, Specificity, and Precedence Order

In terms of specificity, the cascade, and which property values get applied to an element, animations currently supersede all other values in the cascade. When an animation is attached to an element, it takes precedence, as if the specificity was even stronger than if the keyframe animation's property values were set inline with an `!important`: as if `<div style="keyframe-property: value !important">`.

# Specificity and !important

In general, the weight of a property attached with an ID selector `1-0-0` should take precedence over a property applied by an element selector `0-0-1`.

However, if that property value was changed via a keyframe animation, it will be applied as if that property/value pair were added as an inline style. The current behavior in all browsers that support animation is as if the property values were declared inline with an added `!important`. This is wrong, according to the specifications. The animation specification states “animations override all normal rules, but are overridden by `!important` rules.” This is a bug in the current implementations and should be resolved eventually.

A property added via a CSS animation, even if that animation was added on a CSS block with very low specificity, will be applied to the element, even if the same property is applied to the same element via a more specific selector, an inline style, or, currently, even the keyterm `!important`—even on three nested ID selectors. Currently, if an `!important` is declared on a property value within the cascade, that will not override the style that was added with



an animation.

The animation is “even more `!important`.”

That being said, don’t include `!important` within your animation declaration block; the property/value upon which it is declared will be ignored.



# Animation Order

If there are multiple animations specifying values for the same property, the property value from the last animation applied will override the previous animations:

```
#colorchange {  
    animation-name: red, green, blue;  
    animation-duration: 11s, 9s, 6s;  
}
```

In this code example, if `red`, `green`, and `blue` are all keyframe animations that change the `color` property to their respective names, once the `animation-name` and `animation-duration` properties are applied to `#colorchange`, for the first six seconds, the property values in `blue` will take precedence, then `green` for three seconds, then `red` for two seconds, before



returning to its default property values.

The default properties of an element are not impacted before the animation starts, and the properties return to their original values after the animation ends unless an `animation-fill-mode` value other than the default `none` has been set. If `animation-fill-mode: both` were added to the mix, the `color` would always be blue, as the last animation, or `blue`, overrides the previous



`green` animation, which overrides the `red` first animation.

## Animation Iteration and `display: none`;

If the `display` property is set to `none` on an element, any animation iterating on that element or its descendants will cease, as if the animation were detached from the element. Updating the `display` property back to a visible value will reattach all the animation properties, restarting the animation from scratch:

```
.snowflake {  
    animation: spin 2s linear 5s 20;  
}
```

The snowflake will spin 20 times; each spin takes 2 seconds, with the first spin starting after 5 seconds. If the snowflake element's `display` property gets set to `none` after 15 seconds, it would have completed 5 spins before disappearing (5-second delay, then 5 spins at 2 seconds each). If the snowflake `display` property changes back to anything other than `none`, the animation starts from scratch: a 5-second delay will elapse again before it starts spinning 20 times. It makes no difference how many animation cycles



iterated before it disappeared from view the first time.

# Animation and the UI Thread

CSS animations have the lowest priority on the UI thread. If you attach multiple animations on page load with positive values for `animation-delay`, the delays expire as prescribed, but the animations may not begin until the UI thread is available to animate.

If the animations require the UI thread (they aren't on the GPU as described in "[Animation chaining](#)"); if you have 20 animations set with an animation delays to start animating at 1-second intervals over 20 seconds, with the `animation-delay` property on each set to `1s`, `2s`, `3s`, `4s`, and so on; if the document or application takes a long time to load, with 11 seconds between the time the animated elements were drawn to the page and the time the JavaScript finished being downloaded, parsed, and executed; the delays of the first 11 animations will have expired and will all commence when the UI thread becomes available. The remaining animations will each then begin animating at one-second intervals.

# **Seizure Disorders**

While you can use animations to create changing content, dynamically changing content can lead to seizures in some users. Always keep accessibility in mind, ensuring the accessibility of your website to people with epilepsy and other seizure disorders.

# **Animation Events and Prefixing**

Let's recap animation-related events we can access with DOM event listeners.

## animationstart

The `animationstart` event occurs at the start of the animation. If there is an `animation-delay`, this event will fire once the delay period has expired. If there is no delay, the `animationstart` event occurs when the animation is applied to the element. Even if there are no iterations, the `animationstart` event still occurs. If there are multiple animations attached to an element, an `animationstart` event will occur for each of the applied valid keyframe animations: generally, one `animationstart` for each valid `animation-name` identifier present:

```
#colorchange {  
    animation: red, green, blue;  
}
```

In this example, as long as the `red`, `green`, and `blue` keyframe animations are valid, while the animations will not be perceptible (as the default duration of `0s` is set on each), there will be three `animationstart` events thrown: one for each animation name.

If the browser requires the `-webkit-` prefix for the animation properties—basically, Safari 8 and earlier and Android 4.4.4 and older—the event is written as `webkitAnimationStart` instead of `animationstart`. Note the `-webkit-` prefix and the camelCasing. It is best to default to the unprefixed syntax and fall back to the prefixed version only when the unprefixed is unavailable.

## **animationend**

The `animationend` event occurs at the conclusion of the last animation. It only occurs once per applied animation: if an element has 3 animations applied to it, like in our `#colorchange` example, the `animationend` event will occur three times, at the end of the animation. In the example, there was no duration for any of the animations; however, the `animationend` event timing is usually equivalent to the result of the following equation:

`(animation-duration * animation-iteration-count) + animation-delay`

Even if there are no iterations, the `animationend` event still occurs once for each animation applied. If the `animation-iteration-count` is set to infinite, the `animationend` event never occurs.

If the browser requires the `-webkit-` prefix for the animation properties, the event is written as `webkitAnimationEnd` instead of `animationend`.

## **animationiteration**

The `animationiteration` event occurs at the end of each iteration of an animation, before the start of the next iteration. If there are no iterations, or the iteration count is less than or equal to one, the `animationiteration` event never occurs. If the iteration count is infinite, the `animationiteration` event occurs ad infinitum, unless there is no duration set or the duration is 0s.

Unlike the `animationstart` and `animationend` events, which each occur once for each animation name, the `animationiteration` event can occur multiple times or no times per animation name, depending on how many iterations occur. Note that the event happens between animation cycles and will not occur at the same time as an `animationend` event. In other words, if the `animation-iteration-count` is an integer, the number of `animationiteration` events that occur is generally one less than the value of the `animation-iteration-count` property as long as the absolute value of any negative delay is less than the duration.

# **Other Considerations**

# Printing Animations

While not actually “animating” on a printed piece of paper, when an animated element is printed, the relevant property values will be printed. Obviously, you can’t see the element animating on a piece of paper, but if the animation caused an element to have a border-radius of 50%, the printed element will have a border-radius of 50%.

<sup>1</sup> All of the examples in this chapter can be found at <http://standardista.com/css3/animations>.

# Chapter 12. CSS and Documents

Cascading Style Sheets (CSS) is a powerful tool that transforms the presentation of a document or a collection of documents, and it has spread to nearly every corner of the web as well as into many ostensibly non-web environments. For example, Gecko-based browsers use CSS to affect the presentation of the browser chrome itself, many RSS clients let you apply CSS to feeds and feed entries, and some instant message clients use CSS to format chat windows. Aspects of CSS can be found in the syntax used by JavaScript frameworks like jQuery. It's everywhere!

# A Brief History of (Web) Style

CSS was first proposed in 1994, just as the Web was beginning to really catch on. At the time, browsers gave all sorts of styling power to the user—the presentation preferences in Mosaic, for example, permitted all manner of font family, size, and color to be defined by the user on a per-element basis. None of this was available to document authors; all they could do was mark a piece of content as a paragraph, as a heading of some level, as preformatted text, or one of a handful of other element types. If a user configured his browser to make all level-one headings tiny and pink and all level-six headings huge and red, well, that was his lookout.

It was into this milieu that CSS was introduced. Its goal was simple: provide a simple, declarative styling language that was flexible for authors and, most importantly, provided styling power to authors and users alike. By means of the “cascade,” these styles could be combined and prioritized so that both authors and readers had a say—though readers always had the last say.

Work quickly advanced and by late 1996, CSS1 was finished. While the newly established CSS Working Group moved forward with CSS2, browsers struggled to implement CSS1 in an interoperable way. Although each individual piece of CSS was fairly simple on its own, the combination of those pieces created some surprisingly complex behaviors. There were also some unfortunate missteps in early implementations, such as the now-infamous discrepancy in box model implementations. These problems threatened to derail CSS altogether, but fortunately some clever proposals were implemented, and browsers began to harmonize. Within a few years, thanks to increasing interoperability and high-profile developments such as the CSS-based redesign of *Wired* magazine and the CSS Zen Garden, CSS began to really catch on.

Before all that happened, though, the CSS Working Group had finalized the CSS2 specification in early 1998. Once CSS2 was finished, work immediately began on CSS3, as well as a clarified version of CSS2 called CSS2.1. In keeping with the spirit of the times, CSS3 was constructed as a

series of (theoretically) standalone modules instead of a single monolithic specification. This approach reflected the then-active XHTML specification, which was split into modules for similar reasons.

The rationale for modularizing CSS3 was that each module could be worked on at its own pace, and particularly critical (or popular) modules could be advanced along the W3C's progress track without being held up by others. Indeed, this has turned out to be the case. By early 2012, three CSS3 modules (along with CSS1 and CSS 2.1) had reached full Recommendation status—CSS Color Level 3, CSS Namespaces, and Selectors Level 3. At that same time, seven modules were at Candidate Recommendation status, and several dozen others were in various stages of Working Draft-ness. Under the old approach, colors, selectors, and namespaces would have had to wait for every other part of the specification to be done or cut before they could be part of a completed specification. Thanks to modularization, they didn't have to wait.

The flip side of that advantage is that it's very hard to speak of a single "CSS3 specification." There really isn't any such thing, nor can there be. Even if every other CSS module were to reach level 3 by, say, late 2016, there was already be a Selectors Level 4 in process. Would we then speak of it as CSS4? What about all the "CSS3" features still coming into play?

So while we can't really point to a single tome and say, "There is CSS3," we can talk of features by the module name under which they are introduced. The flexibility modules permit more than makes up for the semantic awkwardness they sometimes create.

With that established, let's get started on understanding CSS. But first, we must speak of markup.

# Elements

*Elements* are the basis of document structure. In HTML, the most common elements are easily recognizable, such as `p`, `table`, `span`, `a`, and `div`. Every single element in a document plays a part in its presentation.

# Replaced and Nonreplaced Elements

Although CSS depends on elements, not all elements are created equally. For example, images and paragraphs are not the same type of element, nor are `span` and `div`. In CSS, elements generally take two forms: replaced and nonreplaced.

## Replaced elements

*Replaced elements* are those where the element's content is replaced by something that is not directly represented by document content. Probably the most familiar HTML example is the `img` element, which is replaced by an image file external to the document itself. In fact, `img` has no actual content, as you can see in this simple example:

```

```

This markup fragment contains only an element name and an attribute. The element presents nothing unless you point it to some external content (in this case, an image specified by the `src` attribute). If you point to a valid image file, the image will be placed in the document. If not, it will either display nothing or the browser will show a “broken image” placeholder.

In a like manner, the `input` element is also replaced—by a radio button, checkbox, or text input box, depending on its type.

## Nonreplaced elements

The majority of HTML elements are *nonreplaced elements*. This means that their content is presented by the user agent (generally a browser) inside a box generated by the element itself. For example, `<span>hi there</span>` is a nonreplaced element, and the text “hi there” will be displayed by the user agent. This is true of paragraphs, headings, table cells, lists, and almost everything else in HTML.

# Element Display Roles

In addition to replaced and nonreplaced elements, CSS uses two other basic types of elements: *block-level* and *inline-level*. There are many more display types, but these are the most basic, and the types to which most if not all other display types refer. The block and inline types will be familiar to authors who have spent time with HTML markup and its display in web browsers; the elements are illustrated in [Figure 12-1](#).

## **h1 (block)**

This paragraph (p) element is a block-level element. The strongly emphasized text is an **inline element, and will line-wrap when necessary**. The content outside of inline elements is actually part of the block element. The content inside inline elements *such as this one* belong to the inline element.

**Figure 12-1.** Block- and inline-level elements in an HTML document

## Block-level elements

*Block-level elements* generate an element box that (by default) fills its parent element's content area and cannot have other elements at its sides. In other words, it generates “breaks” before and after the element box. The most familiar block elements from HTML are `p` and `div`. Replaced elements can be block-level elements, but usually they are not.

List items are a special case of block-level elements. In addition to behaving in a manner consistent with other block elements, they generate a marker—typically a bullet for unordered lists and a number for ordered lists—that is “attached” to the element box. Except for the presence of this marker, list items are in all other ways identical to other block elements.

## Inline-level elements

*Inline-level elements* generate an element box within a line of text and do not break up the flow of that line. The best inline element example is the `a`

element in HTML. Other candidates are `strong` and `em`. These elements do not generate a “break” before or after themselves, so they can appear within the content of another element without disrupting its display.

Note that while the names “block” and “inline” share a great deal in common with block- and inline-level elements in HTML, there is an important difference. In HTML, block-level elements cannot descend from inline-level elements. In CSS, there is no restriction on how display roles can be nested within each other.

To see how this works, let’s consider a CSS property, `display`:

*Values:*

```
none | inline | block | inline-block | list-item | inline-list-item |
run-in | flex | inline-flex | grid | inline-grid | table | inline-
table | table-row-group | table-header-group | table-footer-group |
table-row | table-column-group | table-column | table-cell |
table-caption | ruby | ruby-base | ruby-text | ruby-base-container |
ruby-text-container | contents
```

*Initial value:*

`inline`

*Applies to:*

All elements

*Inherited:*

No

*Computed value:*

Varies for floated, positioned, and root elements (see CSS2.1, section 9.7); otherwise, as specified

You may have noticed that there are a lot of values, only three of which I’ve

even come close to mentioning: `block`, `inline`, and `list-item`. Most of these will be dealt with elsewhere in the book; for example, `grid` and `inline-grid` will be covered in a separate chapter about grid layout, and the table-related values are all covered in a chapter on CSS table layout.

For now, let's just concentrate on `block` and `inline`. Consider the following markup:

```
<body>
<p>This is a paragraph with <em>an inline element</em> within it.
</body>
```

Here we have two block elements (`body` and `p`) and an inline element (`em`). According to the HTML specification, `em` can descend from `p`, but the reverse is not true. Typically, the HTML hierarchy works out so that inlines descend from blocks, but not the other way around.

CSS, on the other hand, has no such restrictions. You can leave the markup as it is but change the display roles of the two elements like this:

```
p {display: inline;}
em {display: block;}
```

This causes the elements to generate a block box inside an inline box. This is perfectly legal and violates no specification in CSS. You would, however, have a problem if you tried to reverse the nesting of the elements in HTML:

```
<em><p>This is a paragraph improperly enclosed by an inline eleme
```

No matter what you do to the display roles via CSS, this is not legal in HTML.

While changing the display roles of elements can be useful in HTML documents, it becomes downright critical for XML documents. An XML document is unlikely to have any inherent display roles, so it's up to the author to define them. For example, you might wonder how to lay out the following snippet of XML:

```
<book>
  <maintitle>Cascading Style Sheets: The Definitive Guide</maintit
```

```
<subtitle>Third Edition</subtitle>
<author>Eric A. Meyer</author>
<publisher>O'Reilly and Associates</publisher>
<pubdate>November 2006</pubdate>
<isbn type="print">978-0-596-52733-4</isbn>
</book>
<book>
  <maintitle>CSS Pocket Reference</maintitle>
  <subtitle>Third Edition</subtitle>
  <author>Eric A. Meyer</author>
  <publisher>O'Reilly and Associates</publisher>
  <pubdate>October 2007</pubdate>
  <isbn type="print">978-0-596-51505-8</isbn>
</book>
```

Since the default value of `display` is `inline`, the content would be rendered as inline text by default, as illustrated in [Figure 12-2](#). This isn't a terribly useful display.

Cascading Style Sheets: The Definitive Guide Third Edition Eric A. Meyer O'Reilly and Associates November 2006 978-0-596-52733-4 CSS Pocket Reference Third Edition Eric A. Meyer O'Reilly and Associates October 2007 978-0-596-51505-8

**Figure 12-2. Default display of an XML document**

You can define the basics of the layout with `display`:

```
book, maintitle, subtitle, author, isbn {display: block;}
publisher, pubdate {display: inline;}
```

You've now set five of the seven elements to be block and two to be inline. This means each of the block elements will be treated much as `div` is treated in HTML, and the two inlines will be treated in a manner similar to `span`.

This fundamental ability to affect display roles makes CSS highly useful in a variety of situations. You could take the preceding rules as a starting point, add a few other styles for greater visual impact, and get the result shown in [Figure 12-3](#).

## **CSS: The Definitive Guide**

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Third Edition

**Eric A. Meyer**

O'Reilly and Associates (November 2006)

978-0-596-52733-4

## **CSS Pocket Reference**

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Third Edition

**Eric A. Meyer**

O'Reilly and Associates (October 2007)

978-0-596-51505-8

**Figure 12-3.** Styled display of an XML document

Before learning how to write CSS in detail, we need to look at how one can associate CSS with a document. After all, without tying the two together, there's no way for the CSS to affect the document. We'll explore this in an HTML setting since it's the most familiar.

# Bringing CSS and HTML Together

I've mentioned that HTML documents have an inherent structure, and that's a point worth repeating. In fact, that's part of the problem with web pages of old: too many of us forgot that documents are supposed to have an internal structure, which is altogether different than a visual structure. In our rush to create the coolest-looking pages on the Web, we bent, warped, and generally ignored the idea that pages should contain information with some structural meaning.

That structure is an inherent part of the relationship between HTML and CSS; without it, there couldn't be a relationship at all. To understand it better, let's look at an example HTML document and break it down by pieces:

```
<html>
<head>
<title>Eric's World of Waffles</title>
<meta http-equiv="content-type" content="text/html; charset=utf-8
<link rel="stylesheet" type="text/css" href="sheet1.css" media="a
<style type="text/css">
/* These are my styles! Yay! */
@import url(sheet2.css);
</style>
</head>
<body>
<h1>Waffles!</h1>
<p style="color: gray;">The most wonderful of all breakfast foods
the waffle—a ridged and cratered slab of home-cooked, fluffy good
that makes every child's heart soar with joy. And they're so easy
Just a simple waffle-maker and some batter, and you're ready for
of aromatic ecstasy!
</p>
</body>
</html>
```

The result of this markup and the applied styles is shown in [Figure 12-4](#).

# Waffles!

---

**The most wonderful of all breakfast foods is the waffle—a ridged and cratered slab of home-cooked, fluffy goodness that makes every child's heart soar with joy. And they're so easy to make! Just a simple waffle-maker and some batter, and you're ready for a morning of aromatic ecstasy!**

**Figure 12-4.** A simple document

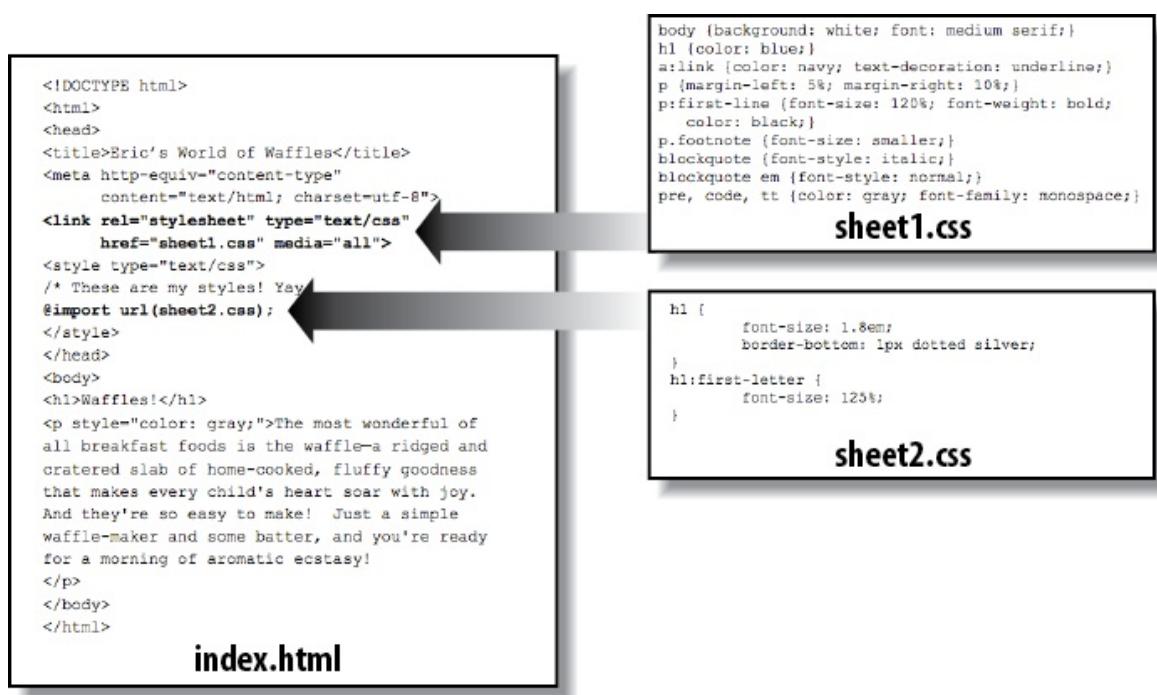
Now, let's examine the various ways this document connects to CSS.

# The link Tag

First, consider the use of the `link` tag:

```
<link rel="stylesheet" type="text/css" href="sheet1.css" media="all"/>
```

The `link` tag is a little-regarded but nonetheless perfectly valid tag that has been hanging around the HTML specification for years, just waiting to be put to good use. Its basic purpose is to allow HTML authors to associate other documents with the document containing the `link` tag. CSS uses it to link style sheets to the document; in [Figure 12-5](#), a style sheet called *sheet1.css* is linked to the document.



**Figure 12-5.** A representation of how external style sheets are applied to documents

These style sheets, which are not part of the HTML document but are still used by it, are referred to as *external style sheets*. This is because they're style sheets that are external to the HTML document. (Go figure.)

To successfully load an external style sheet, `link` must be placed inside the `head` element but may not be placed inside any other element, rather like `title`. This will cause the web browser to locate and load the style sheet and use whatever styles it contains to render the HTML document in the manner shown in [Figure 12-5](#). Also shown in [Figure 12-5](#) is the loading of the external `sheet2.css` via the `@import` declaration. Imports must be placed at the beginning of the style sheet that contains them, but they are otherwise unconstrained.

And what is the format of an external style sheet? It's simply a list of rules, just like those we saw in the previous section and in the example HTML document, but in this case, the rules are saved into their own file. Just remember that no HTML or any other markup language can be included in the style sheet—only style rules. Here are the contents of an external style sheet:

```
h1 {color: red;}  
h2 {color: maroon; background: white;}  
h3 {color: white; background: black;  
    font: medium Helvetica;}
```

That's all there is to it—no HTML markup or comments at all, just plain-and-simple style declarations. These are saved into a plain-text file and are usually given an extension of `.css`, as in `sheet1.css`.

#### Warning

An external style sheet cannot contain any document markup at all, only CSS rules and CSS comments, both of which are explained later in the chapter. The presence of markup in an external style sheet can cause some or all of it to be ignored.

The filename extension is not required, but some older browsers won't recognize the file as containing a style sheet unless it actually ends with `.css`, even if you *do* include the correct `type="text/css"` in the `link` element. In fact, some web servers won't hand over a file as `text/css` unless its filename ends with `.css`, though that can usually be fixed by changing the server's configuration files.

## Attributes

For the rest of the `link` tag, the attributes and values are fairly straightforward. `rel` stands for “relation,” and in this case, the relation is `stylesheet`. The attribute `type` is always set to `text/css`. This value describes the type of data that will be loaded using the `link` tag. That way, the web browser knows that the style sheet is a CSS style sheet, a fact that will determine how the browser deals with the data it imports. After all, there may be other style languages used in the future, so it’s important to declare which language you’re using.

Next, we find the `href` attribute. The value of this attribute is the URL of your style sheet. This URL can be either absolute or relative, depending on what works for you. In our example, of course, the URL is relative. It just as easily could have been something like <http://meyerweb.com/sheet1.css>.

Finally, we have a `media` attribute. The value of this attribute is one or more *media descriptors*, which are rules regarding media types and the features of those media, with each rule separated by a comma. Thus, for example, you can use a linked style sheet in both screen and projection media:

```
<link rel="stylesheet" type="text/css" href="visual-sheet.css"  
      media="screen, projection">
```

Media descriptors can get quite complicated, and are explained in detail later in the chapter. For now, we’ll stick with the basic media types shown.

Note that there can be more than one linked style sheet associated with a document. In these cases, only those `link` tags with a `rel` of `stylesheet` will be used in the initial display of the document. Thus, if you wanted to link two style sheets named `basic.css` and `splash.css`, it would look like this:

```
<link rel="stylesheet" type="text/css" href="basic.css">  
<link rel="stylesheet" type="text/css" href="splash.css">
```

This will cause the browser to load both style sheets, combine the rules from each, and apply them all to the document. For example:

```
<link rel="stylesheet" type="text/css" href="basic.css">
```

```
<link rel="stylesheet" type="text/css" href="splash.css">

<p class="a1">This paragraph will be gray only if styles from the
stylesheet 'basic.css' are applied.</p>
<p class="b1">This paragraph will be gray only if styles from the
stylesheet 'splash.css' are applied.</p>
```

The one attribute that is not in your example markup, but could be, is the `title` attribute. This attribute is not often used, but it could become important in the future and, if used improperly, can have unexpected effects. Why? We will explore that in the next section.

## Alternate style sheets

It's also possible to define *alternate style sheets*. These are defined by making the value of the `rel` attribute `alternate stylesheet`, and they are used in document presentation only if selected by the user.

Should a browser be able to use alternate style sheets, it will use the values of the `link` element's `title` attributes to generate a list of style alternatives. So you could write the following:

```
<link rel="stylesheet" type="text/css"
      href="sheet1.css" title="Default">
<link rel="alternate stylesheet" type="text/css"
      href="bigtext.css" title="Big Text">
<link rel="alternate stylesheet" type="text/css"
      href="zany.css" title="Crazy colors!">
```

Users could then pick the style they want to use, and the browser would switch from the first one, labeled "Default" in this case, to whichever the user picked. [Figure 12-6](#) shows one way in which this selection mechanism might be accomplished (and in fact was, early in the resurgence of CSS).

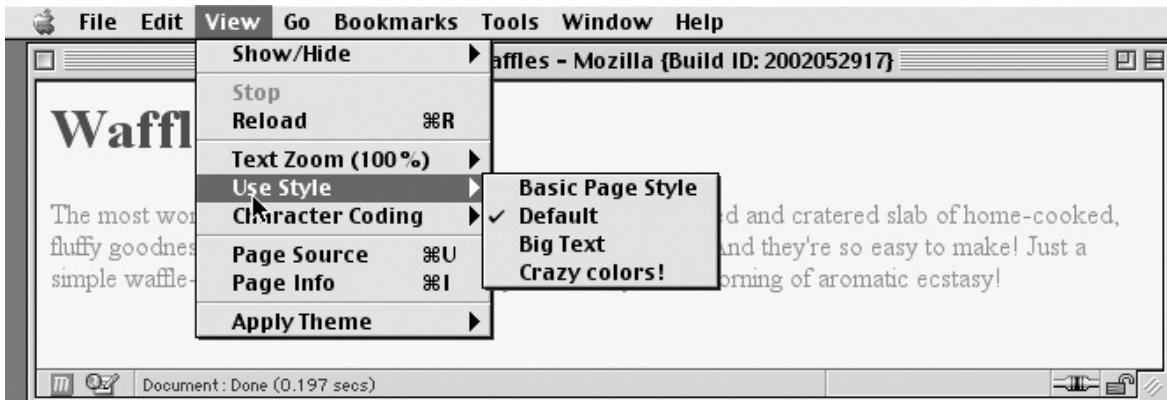


Figure 12-6. A browser offering alternate style sheet selection

**Note**

As of late 2016, alternate style sheets were supported in most Gecko-based browsers like Firefox, and in Opera. They could be supported in the Internet Explorer family through the use of JavaScript but are not natively supported by those browsers. The WebKit family did not support selecting alternate style sheets. (Compare this to the age of the browser shown in [Figure 12-6](#). It's almost shocking.)

It is also possible to group alternate style sheets together by giving them the same `title` value. Thus, you make it possible for the user to pick a different presentation for your site in both screen and print media. For example:

```
<link rel="stylesheet" type="text/css"
      href="sheet1.css" title="Default" media="screen">
<link rel="stylesheet" type="text/css"
      href="print-sheet1.css" title="Default" media="print">
<link rel="alternate stylesheet" type="text/css"
      href="bigtext.css" title="Big Text" media="screen">
<link rel="alternate stylesheet" type="text/css"
      href="print-bigtext.css" title="Big Text" media="print">
```

If a user selects “Big Text” from the alternate style sheet selection mechanism in a conforming user agent, then `bigtext.css` will be used to style the document in the screen medium, and `print-bigtext.css` will be used in the print medium. Neither `sheet1.css` nor `print-sheet1.css` will be used in any medium.

Why is that? Because if you give a `link` with a `rel` of `stylesheet` a title, then you are designating that style sheet as a *preferred style sheet*. This means that its use is preferred to alternate style sheets, and it will be used when the document is first displayed. Once you select an alternate style sheet, however, the preferred style sheet will *not* be used.

Furthermore, if you designate a number of style sheets as preferred, then all but one of them will be ignored. Consider:

```
<link rel="stylesheet" type="text/css"
      href="sheet1.css" title="Default Layout">
<link rel="stylesheet" type="text/css"
      href="sheet2.css" title="Default Text Sizes">
<link rel="stylesheet" type="text/css"
      href="sheet3.css" title="Default Colors">
```

All three `link` elements now refer to preferred style sheets, thanks to the presence of a `title` attribute on all three, but only one of them will actually be used in that manner. The other two will be ignored completely. Which two? There's no way to be certain, as HTML doesn't provide a method of determining which preferred style sheets should be ignored and which should be used.

If you simply don't give a style sheet a title, then it becomes a *persistent style sheet* and is always used in the display of the document. Often, this is exactly what an author wants.

# The style Element

The `style` element is one way to include a style sheet, and it appears in the document itself:

```
<style type="text/css">...</style>
```

`style` should always use the attribute `type`; in the case of a CSS document, the correct value is "`text/css`", just as it was with the `link` element.

The `style` element should always start with `<style type="text/css">`, as shown in the preceding example. This is followed by one or more styles and is finished with a closing `</style>` tag. It is also possible to give the `style` element a `media` attribute, which functions in the same manner as previously discussed for linked style sheets.

The styles between the opening and closing `style` tags are referred to as the *document style sheet* or the *embedded style sheet* (because this kind of style sheet is embedded within the document). It will contain many of the styles that will apply to the document, but it can also contain multiple links to external style sheets using the `@import` directive.

# The @import Directive

Now we'll discuss the stuff that is found inside the `style` tag. First, we have something very similar to `link`: the `@import` directive:

```
@import url(sheet2.css);
```

Just like `link`, `@import` can be used to direct the web browser to load an external style sheet and use its styles in the rendering of the HTML document. The only major difference is in the actual syntax and placement of the command. As you can see, `@import` is found inside the `style` container. It must be placed before the other CSS rules or it won't work at all. Consider this example:

```
<style type="text/css">
@import url(styles.css); /* @import comes first */
h1 {color: gray;}
</style>
```

Like `link`, there can be more than one `@import` statement in a document. Unlike `link`, however, the style sheets of every `@import` directive will be loaded and used; there is no way to designate alternate style sheets with `@import`. So, given the following markup:

```
@import url(sheet2.css);
@import url(blueworld.css);
@import url(zany.css);
```

...all three external style sheets will be loaded, and all of their style rules will be used in the display of the document.

As with `link`, you can restrict imported style sheets to one or more media by providing media descriptors after the style sheet's URL:

```
@import url(sheet2.css) all;
@import url(blueworld.css) screen;
@import url(zany.css) projection, print;
```

As noted in the section about the `link` element, media descriptors can get

quite complicated, and are explained in detail later in the chapter.

`@import` can be highly useful if you have an external style sheet that needs to use the styles found in other external style sheets. Since external style sheets cannot contain any document markup, the `link` element can't be used—but `@import` can. Therefore, you might have an external style sheet that contains the following:

```
@import url(http://example.org/library/layout.css);  
@import url(basic-text.css);  
@import url(printer.css) print;  
body {color: red;}  
h1 {color: blue;}
```

Well, maybe not those exact styles, but you get the idea. Note the use of both absolute and relative URLs in the previous example. Either URL form can be used, just as with `link`.

Note also that the `@import` directives appear at the beginning of the style sheet, as they did in the example document. CSS requires the `@import` directive to come before any other rules in a style sheet. An `@import` that comes after other rules (e.g., `body {color: red;}`) will be ignored by conforming user agents.

**Warning**

Older versions of Internet Explorer for Windows do not ignore any `@import` directive, even those that come after other rules. Since other browsers do ignore improperly placed `@import` directives, it is easy to mistakenly place the `@import` directive incorrectly and thus alter the display in other browsers.

# HTTP Linking

There is another, far more obscure way to associate CSS with a document: you can link the two together via HTTP headers.

Under Apache, this can be accomplished by adding a reference to the CSS file in a `.htaccess` file. For example:

```
Header add Link "</ui/testing.css>;rel=stylesheet;type=text/css"
```

This will cause supporting browsers to associate the referenced style sheet with any documents served from under that `.htaccess` file. The browser will then treat it as if it were a linked style sheet. Alternatively, and probably more efficiently, you can add an equivalent rule to the server's `httpd.conf` file:

```
<Directory /path/to/ /public/html/directory>
Header add Link "</ui/testing.css>;rel=stylesheet;type=text/css"
</Directory>
```

The effect is exactly the same in supporting browsers. The only difference is in where you declare the linking.

No doubt you noticed the use of the term “supporting browsers.” As of late 2016, the widely used browsers that support HTTP linking of style sheets are the Firefox family and Opera. That restricts this technique mostly to development environments based on one of those browsers. In that situation, you can use HTTP linking on the test server to mark when you’re on the development site as opposed to the public site. It’s also an interesting way to hide styles from the WebKit and Internet Explorer families, assuming you have a reason to do so.

## Note

There are equivalents to this technique in common scripting languages such as PHP and IIS, both of which allow the author to emit HTTP headers. It’s also possible to use such languages to explicitly write a `link` element into the

document based on the server offering up the document. This is a more robust approach in terms of browser support: every browser supports the `link` element.

# Inline Styles

For cases where you want to simply assign a few styles to one individual element, without the need for embedded or external style sheets, employ the HTML attribute `style` to set an *inline style*:

```
<p style="color: gray;">The most wonderful of all breakfast foods  
the waffle—a ridged and cratered slab of home-cooked, fluffy good  
</p>
```

The `style` attribute can be associated with any HTML tag whatsoever, except for those tags that are found outside of `body` (`head` or `title`, for instance).

The syntax of a `style` attribute is fairly ordinary. In fact, it looks very much like the declarations found in the `style` container, except here the curly braces are replaced by double quotation marks. So `<p style="color: maroon; background: yellow;">` will set the text color to be maroon and the background to be yellow *for that paragraph only*. No other part of the document will be affected by this declaration.

Note that you can only place a declaration block, not an entire style sheet, inside an inline `style` attribute. Therefore, you can't put an `@import` into a `style` attribute, nor can you include any complete rules. The only thing you can put into the value of a `style` attribute is what might go between the curly braces of a rule.

Use of the `style` attribute is not generally recommended. Indeed, it is very unlikely to appear in XML languages other than HTML. Many of the primary advantages of CSS—the ability to organize centralized styles that control an entire document's appearance or the appearance of all documents on a web server—are negated when you place styles into a `style` attribute. In many ways, inline styles are not much better than the `font` tag, although they do have a good deal more flexibility in terms of what visual effects they can apply.

# Style Sheet Contents

So after all of that, what about the actual contents of the style sheets? You know, stuff like this:

```
h1 {color: maroon;}  
body {background: yellow;}
```

Styles such as these comprise the bulk of any embedded style sheet—simple and complex, short and long. Rarely will you have a document where the `style` element does not contain any rules, although it's possible to have a simple list of `@import` declarations with no actual rules like those shown above.

Before we get going on the rest of the book, though, there are a few top-level things to cover regarding what can or can't go into a style sheet.

# Markup

*There is no markup in style sheets.* This might seem obvious, but you'd be surprised. The one exception is HTML comment markup, which is permitted inside `style` elements for historical reasons:

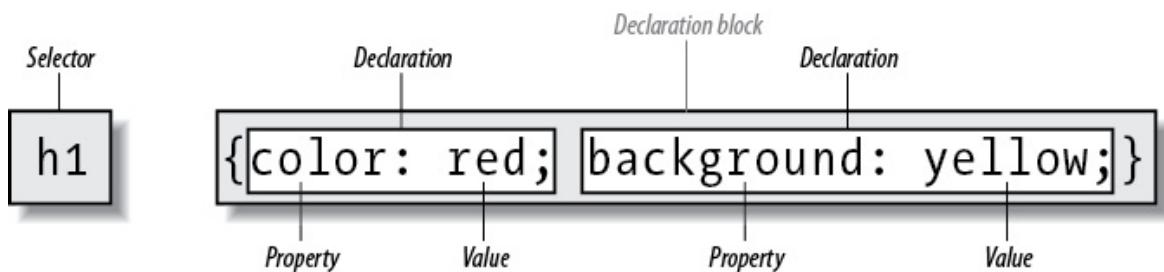
```
<style type="text/css"><!--  
h1 {color: maroon;}  
body {background: yellow;}  
--></style>
```

That's it.

# Rule Structure

To illustrate the concept of rules in more detail, let's break down the structure.

Each rule has two fundamental parts: the *selector* and the *declaration block*. The declaration block is composed of one or more *declarations*, and each declaration is a pairing of a *property* and a *value*. Every style sheet is made up of a series of rules. [Figure 12-7](#) shows the parts of a rule.



**Figure 12-7.** The structure of a rule

The selector, shown on the left side of the rule, defines which piece of the document will be affected. In [Figure 12-7](#), h1 elements are selected. If the selector were p, then all p (paragraph) elements would be selected.

The right side of the rule contains the declaration block, which is made up of one or more declarations. Each declaration is a combination of a CSS property and a value of that property. In [Figure 12-7](#), the declaration block contains two declarations. The first states that this rule will cause parts of the document to have a color of red, and the second states that part of the document will have a background of yellow. So, all of the h1 elements in the document (defined by the selector) will be styled in red text with a yellow background.

## Vendor prefixing

Sometimes you'll see pieces of CSS with dashes and labels in front of them,

like this: `-o-border-image`. These are called *vendor prefixes*, and are a way for browser vendors to mark properties, values, or other bits of CSS as being experimental or proprietary (or both). As of late 2016, there were a few vendor prefixes in the wild, with the most common being shown in [Table 12-1](#).

Table 12-1. Some common vendor prefixes

Prefix	Vendor
<code>-epub-</code>	International Digital Publishing Forum ePub format
<code>-moz-</code>	Mozilla-based browsers (e.g., Firefox)
<code>-ms-</code>	Microsoft Internet Explorer
<code>-o-</code>	Opera-based browsers
<code>-webkit-</code>	WebKit-based browsers (e.g., Safari and Chrome)

As [Table 12-1](#) implies, the generally accepted format of a vendor prefix is a dash, a label, and a dash, although a few prefixes erroneously omit the first dash.

The uses and abuses of vendor prefixes are long, tortuous, and beyond the scope of this book. Suffice to say that they started out as a way for vendors to test out new features, thus helping speed interoperability without worrying about being locked into legacy behaviors that were incompatible with other browsers. This avoided a whole class of problems that nearly strangled CSS in its infancy. Unfortunately, prefixed properties were then publicly deployed by web authors and ended up causing a whole new class of problems.

As of late 2016, vendor prefixes are a dwindling breed, with old prefixed properties and values being slowly removed from browser implementations.

It's entirely possible that you'll never write prefixed CSS, but you may encounter it in the wild, or inherit it in a legacy codebase.

# Whitespace Handling

CSS is basically insensitive to whitespace between rules, and largely insensitive to whitespace within rules, although there are a few exceptions.

In general, CSS treats whitespace just like HTML does: any sequence of whitespace characters is collapsed to a single space for parsing purposes. Thus, you can format the hypothetical `rainbow` rule in the following ways:

```
rainbow: infrared    red    orange    yellow    green    blue    indigo
rainbow:
    infrared    red    orange    yellow    green    blue    indigo    vio
rainbow:
    infrared
    red
    orange
    yellow
    green
    blue
    indigo
    violet
    ultraviolet
;
```

...as well as any other separation patterns you can think up. The only restriction is that the separating characters be whitespace: an empty space, a tab, or a newline, alone or in combination, as many as you like.

Similarly, you can format series of rules with whitespace in any fashion you like. These are just five of an effectively infinite number of possibilities:

```
html{color:black;}
body {background: white;}
p {
    color: gray;
}
h2 {
    color : silver ;
}
ol
{
    color
```

```
:  
silver  
;  
}
```

As you can see from the first rule, whitespace can be largely omitted. Indeed, this is usually the case with “minified” CSS, which is CSS that’s had every last possible bit of extraneous whitespace removed. The rules after the first two use progressively more extravagant amounts of whitespace until, in the last rule, pretty much everything that can be separated onto its own line has been.

Any of these approaches are valid, so you should pick the formatting that makes the most sense—that is, is easiest to read—in your eyes, and stick with it.

There are some places where the presence of whitespace is actually required. The most common example is when separating a list of keywords in a value, as in the hypothetical rainbow examples. Those must always be whitespace-separated.

# CSS Comments

CSS does allow for comments. These are very similar to C/C++ comments in that they are surrounded by /\* and \*/:

```
/* This is a CSS1 comment */
```

Comments can span multiple lines, just as in C++:

```
/* This is a CSS1 comment, and it  
can be several lines long without  
any problem whatsoever. */
```

It's important to remember that CSS comments cannot be nested. So, for example, this would not be correct:

```
/* This is a comment, in which we find  
another comment, which is WRONG  
    /* Another comment */  
and back to the first comment */
```

Of course, this is hardly ever desirable to nest comments, so this limitation is no big deal.

## Warning

One way to create “nested” comments accidentally is to temporarily comment out a large block of a style sheet that already contains a comment. Since CSS doesn't permit nested comments, the “outside” comment will end where the “inside” comment ends.

Unfortunately, there is no “rest of the line” comment pattern such as // or # (the latter of which is reserved for ID selectors anyway). The only comment pattern in CSS is /\* \*/. Therefore, if you wish to place comments on the same line as markup, then you need to be careful about how you place them. For example, this is the correct way to do it:

```
h1 {color: gray;}      /* This CSS comment is several lines */
```

```
h2 {color: silver;} /* long, but since it is alongside */
p {color: white;}   /* actual styles, each line needs to */
pre {color: gray;}  /* be wrapped in comment markers. */
```

Given this example, if each line isn't marked off, then most of the style sheet will become part of the comment and thus will not work:

```
h1 {color: gray;}  /* This CSS comment is several lines
h2 {color: silver;} long, but since it is not wrapped
p {color: white;}  in comment markers, the last three
pre {color: gray;} styles are part of the comment. */
```

In this example, only the first rule (`h1 {color: gray;}`) will be applied to the document. The rest of the rules, as part of the comment, are ignored by the browser's rendering engine.

**Note**

CSS comments are treated by the CSS parser as if they do not exist at all, and so do not count as whitespace for parsing purposes. This means you can put them into the middle of rules—even right inside declarations!

# Media Queries

With media queries, an author can define the media environment in which a given style sheet is used by the browser. In the past, this was handled by setting media types via the `media` attribute on the `link` element, on a `style` element, or in the media descriptor of an `@import` or `@media` declaration. Media queries take this concept several steps further by allowing authors to choose style sheets based on the features of a given media type, using what are called media descriptors.

# Usage

Media queries can be employed in the following places:

- The `media` attribute of a `link` element.
- The `media` attribute of a `style` element.
- The media descriptor portion of an `@import` declaration.
- The media descriptor portion of an `@media` declaration.

Queries can range from simple media types to complicated combinations of media types and features.

# Simple Media Queries

Let's look at some simple media blocks before covering all of the possibilities of media queries. Suppose we want some differing styles for situations where the styles are shown in a projection setting, such as a slide show. Here are two very simple bits of CSS:

```
h1 {color: maroon;}  
 @media projection {  
     body {background: yellow;}  
 }
```

In this example, `h1` elements will be colored maroon in all media, but the `body` element will get a yellow background only in a projection medium.

You can have as many `@media` blocks as you like in a given style sheet, each with its own set of media descriptors (see later in this chapter for details). You could even encapsulate all of your rules in an `@media` block if you chose:

```
@media all {  
     h1 {color: maroon;}  
     body {background: yellow;}  
 }
```

However, since this is exactly the same as if you stripped off the first and last line shown, there isn't a whole lot of point to doing so.

## Note

The indentation shown in this section was solely for purposes of clarity. You do not have to indent the rules found inside an `@media` block, but you're welcome to do so if it makes your CSS easier for you to read.

The place where we saw `projection` and `all` in those examples is where media queries are set. These queries rely on a combination of terms that describe the type of media to be considered, as well as descriptions of the media's parameters (e.g., resolution or display height), to determine when

blocks of CSS should be applied.

# Media Types

The most basic form of media queries are *media types*, which first appeared in CSS2. These are simple labels for different kinds of media. They are:

`all`

Use in all presentational media.

`aural`

Use in speech synthesizers, screen readers, and other audio renderings of the document.

`braille`

Use when rendering the document with a Braille device.

`embossed`

Use when printing with a Braille printing device.

`handheld`

Use on handheld devices like personal digital assistants or web-enabled cell phones.

`print`

Use when printing the document for sighted users and also when displaying a “print preview” of the document.

`projection`

Use in a projection medium, such as a digital projector used to present a slideshow when delivering a speech.

`screen`

Use when presenting the document in a screen medium like a desktop computer monitor. All web browsers running on such systems are screen-medium user agents.

tty

Use when delivering the document in a fixed-pitch environment like a teletype printer.

tv

Use when the document is being presented on a television.

The majority of these media types are not supported by any current web browser. The three most widely supported ones are `all`, `screen`, and `print`. As of this writing, some browsers also support `projection`, which allows a document to be presented as a slideshow, whereas several mobile-device browsers support the `handheld` type.

Multiple media types can be specified using a comma-separated list. The following four examples are all equivalent ways of applying a style sheet (or a block of rules) in both screen and projection media.

```
<link type="text/css" href="frobozz.css" media="screen, projection"
<style type="text/css" media="screen, projection">...</style>
@import url(frobozz.css) screen, projection;
@media screen, projection {...}
```

Things get interesting when you add feature-specific descriptors, such as values that describe the resolution or color depth of a given medium, to these media types.

# Media Descriptors

The placement of media queries will be very familiar to any author who has ever set a media type on a `link` element or an `@import` declaration. Here are two essentially equivalent ways of applying an external style sheet when rendering the document on a color printer:

```
<link href="print-color.css" type="text/css" media="print and (color)" rel="stylesheet"/>  
@import url(print-color.css) print and (color);
```

Anywhere a media type can be used, a media query can be used. This means that, following on the examples of the previous section, it is possible to list more than one query in a comma-separated list:

```
<link href="print-color.css" type="text/css"  
      media="print and (color), projection and (color)" rel="stylesheet"/>  
@import url(print-color.css) print and (color), projection and (color);
```

In any situation where even one of the media queries evaluates to “true,” the associated style sheet is applied. Thus, given the previous `@import`, `print-color.css` will be applied if rendering to a color printer *or* to a color projection environment. If printing on a black-and-white printer, both queries will evaluate to “false” and `print-color.css` will not be applied to the document. The same holds true in any screen medium, a grayscale projection environment, an aural media environment, and so forth.

Each media descriptor is composed of a media type and one or more listed media features, with each media feature descriptor enclosed in parentheses. If no media type is provided, then it is assumed to be `all`, which makes the following two examples exactly equivalent:

```
@media all and (min-resolution: 96dpi) {...}  
@media (min-resolution: 960dpi) {...}
```

Generally speaking, a media feature descriptor is formatted like a property-

value pair in CSS. There are a few differences, most notably that some features can be specified without an accompanying value. Thus, for example, any color-based medium will be matched using `(color)`, whereas any color medium using a 16-bit color depth is matched using `(color: 16)`. In effect, the use of a descriptor without a value is a true/false test for that descriptor: `(color)` means “is this medium in color?”

Multiple feature descriptors can be linked with the `and` logical keyword. In fact, there are two logical keywords in media queries:

`and`

Links together two or more media features in such a way that all of them must be true for the query to be true. For example, `(color)` `and` `(orientation: landscape)` `and` `(min-device-width: 800px)` means that all three conditions must be satisfied: if the media environment has color, is in landscape orientation, and the device’s display is at least 800 pixels wide, then the style sheet is used.

`not`

Negates the entire query so that if all of the conditions are true, then the style sheet is *not* applied. For example, `not (color)` `and` `(orientation: landscape)` `and` `(min-device-width: 800px)` means that if the three conditions are satisfied, the statement is negated. Thus, if the media environment has color, is in landscape orientation, and the device’s display is at least 800 pixels wide, then the style sheet is *not* used. In all other cases, it will be used.

Note that the `not` keyword can only be used at the beginning of a media query. It is *not* legal to write something like `(color) and not (min-device-width: 800px)`. In such cases, the query will be ignored. Note also that browsers too old to understand media queries will always skip a style sheet whose media descriptor starts with `not`.

There is no OR keyword for use in media queries. Instead, the commas that separate a list of queries serve the function of an OR—`screen, print` means “apply if the media is screen or print.” Instead of `screen` and `(max-color:`

2) or (monochrome), which is invalid and thus ignored, you should write screen and (max-color: 2), screen and (monochrome).

There is one more keyword, `only`, which is designed to create deliberate backwards incompatibility. Yes, really.

`only`

Used to hide a style sheet from browsers too old to understand media queries. For example, to apply a style sheet in all media, but only in those browsers that understand media queries, you write something like `@import url(new.css) only all`. In browsers that do understand media queries, the `only` keyword is ignored and the style sheet is applied. In browsers that do not understand media queries, the `only` keyword creates an apparent media type of `only all`, which is not valid. Thus, the style sheet is not applied in such browsers. Note that the `only` keyword can only be used at the beginning of a media query.

# Media Feature Descriptors

So far we've seen a number of media feature descriptors in the examples, but not a complete list of the possible descriptors and their values. Let us fix that now!

Note that none of the following values can be negative, and remember that feature descriptors are *always* enclosed in parentheses.

*Descriptors:* width, min-width, max-width

*Values:*

<length>

Refers to the width of the display area of the user agent. In a screen-media web browser, this is the width of the viewport plus any scrollbars. In paged media, this is the width of the page box. Thus, `(min-width: 850px)` applies when the viewport is greater than 850 pixels wide.

*Descriptors:* device-width, min-device-width, max-device-width

*Values:*

<length>

Refers to the width of the complete rendering area of the output device. In screen media, this is the width of the screen. In paged media, this is the width of the page. Thus, `(max-device-width: 1200px)` applies when the device's output area is less than 1200 pixels wide.

*Descriptors:* height, min-height, max-height

*Values:*

<length>

Refers to the height of the display area of the user agent. In a screen-media web browser, this is the height of the viewport plus any scrollbars. In paged media, this is the height of the page box. Thus, `(height: 567px)` applies when the viewport's height is precisely 567 pixels tall.

*Descriptors:* `device-height`, `min-device-height`, `max-device-height`

*Values:*

`<length>`

Refers to the height of the complete rendering area of the output device. In screen media, this is the height of the screen. In paged media, this is the height of the page. Thus, `(max-device-height: 400px)` applies when the device's output area is less than 400 pixels tall.

*Descriptors:* `aspect-ratio`, `min-aspect-ratio`, `max-aspect-ratio`

*Values:*

`<ratio>`

Refers to the ratio that results from comparing the `width` media feature to the `height` media feature (see the definition of `<ratio>` in the next section). Thus, `(min-aspect-ratio: 2/1)` applies to any viewport whose width-to-height ratio is at least 2:1.

*Descriptors:* `device-aspect-ratio`, `min-device-aspect-ratio`, `max-device-aspect-ratio`

*Values:*

`<ratio>`

Refers to the ratio that results from comparing the `device-width` media feature to the `device-height` media feature (see the definition of `<ratio>` in the next section). Thus, `(device-aspect-ratio: 16/9)` applies to any output device whose display area width-to-height is exactly 16:9.

*Descriptors*: color, min-color, max-color

*Values*:

<integer>

Refers to the presence of color-display capability in the output device, with an optional number representing the number of bits used in each color components. Thus, (color) applies to any device with any color depth at all, whereas (min-color: 4) means there must be at least four bits used per color component. Any device that does not support color will return 0.

*Descriptors*: color-index, min-color-index, max-color-index

*Values*:

<integer>

Refers to the total number of colors available in the output device's color lookup table. Any device that does not use a color lookup table will return 0. Thus, (min-color-index: 256) applies to any device with a minimum of 256 colors available.

*Descriptors*: monochrome, min-monochrome, max-monochrome

*Values*:

<integer>

Refers to the presence of a monochrome display, with an optional number of bits-per-pixel in the output device's frame buffer. Any device that is not monochrome will return 0. Thus, (monochrome) applies to any monochrome output device, whereas (min-monochrome: 2) means any monochrome output device with a minimum of two bits per pixel in the frame buffer.

*Descriptors*: resolution, min-resolution, max-resolution

*Values:*

<resolution>

Refers to the resolution of the output device in terms of pixel density, measured in either dots-per-inch (`dpi`) or dots-per-centimeter (`dpcm`); see the definition of <resolution> in the next section for details. If an output device has pixels that are not square, then the least dense axis is used; for example, if a device is 100dpcm along one axis and 120dpcm along the other, then `100` is the value returned. Additionally, in such non-square cases, a bare `resolution` feature query can never match (though `min-resolution` and `max-resolution` can).

*Descriptor:* `orientation`

*Values:*

`portrait` | `landscape`

Refers to the output device's total output area, where `portrait` is returned if the media feature `height` is equal to or greater than the media feature `width`. Otherwise, the result is `landscape`.

*Descriptor:* `scan`

*Values:*

`progressive` | `interlace`

Refers to the scanning process used in an output device with a media type of `tv`.

*Descriptor:* `grid`

*Values:*

`0` | `1`

Refers to the presence (or absence) of a grid-based output device, such

as a `tty` terminal. A grid-based device will return 1; otherwise, 0 is returned.

# New Value Types

There are two new value types introduced by media queries that (as of late 2016) are not used in any other context.

*<ratio>*

A ratio value is two positive *<integer>* values separated by a solidus (/) and optional whitespace. The first value refers to the width, and the second to the height. Thus, to express a height-to-width ratio of 16:9, you can write 16/9 or 16 / 9. As of this writing, there is no facility to express a ratio as a single real number, or to use a colon separator instead of a solidus.

*<resolution>*

A resolution value is a positive *<integer>* followed by either of the unit identifiers `dpi` (dots per inch) or `dpcm` (dots per centimeter). In CSS terms, a “dot” is any display unit, the most familiar of which is the pixel. As usual, whitespace is not permitted between the *<integer>* and the identifier. Therefore, a display whose display has exactly 150 pixels (dots) per inch is matched with `150dpi`.

# Feature queries

In the 2015-2016 time frame, CSS gained the ability to apply blocks of CSS when certain CSS property-value combinations were supported by the user agent. These are known as *feature queries*.

They're very similar to media queries in structure. Consider a situation where you want to only apply color to element if `color` is a supported property. (Which it certainly should be!) That would look like this:

```
@supports (color: black) {  
    body {color: black;}  
    h1 {color: purple;}  
    h2 {color: navy;}  
}
```

That says, in effect, “If you recognize and can do something with the property-value combination `color: black`, apply these styles. Otherwise, skip these styles.” In user agents that don’t understand `@supports`, the entire block is skipped over.

Feature queries are a perfect way to progressively enhance your styles. For example, suppose you want to add some grid layout to your existing float-and-inline-block layout. You can keep the old layout scheme, and then later in the stylesheet include a block like this:

```
@supports (display: grid ) {  
    section#main {display: grid;}  
    .columns {float: none;}  
    /* ... and so on ... */  
}
```

This block of styles will be applied in browsers that understand grid display, switching off the old `display` values and `float` styles, and applying the styles needed to make things work in a grid-based future. Browsers too old to understand grid layout will most likely also be too old to understand `@supports`, so they’ll skip the whole block and never try to apply the grid styles.

Feature queries can be embedded inside each other, and indeed can be embedded inside media queries, as well as vice versa. You could write screen and print styles based on flexible-box layout, and wrap those media blocks in an `@supports (display: flex)` block.

```
@supports (display: flex) {  
    @media screen {  
        /* screen flexbox styles go here */  
    }  
    @media print {  
        /* print flexbox styles go here */  
    }  
}
```

Conversely, you could add `@supports()` blocks inside various responsive-design media query blocks.

```
@media screen and (max-width: 30em) {  
    @supports (display: flex) {  
        /* small-screen flexbox styles go here */  
    }  
}  
@media screen and (min-width: 30em) {  
    @supports (display: flex) {  
        /* large-screen flexbox styles go here */  
    }  
}
```

How you organize these blocks is really up to you.

As with media queries, feature queries also permit logical operators. Suppose we want to apply styles only if a user agent supports both grid layout *and* CSS shapes. Here's how that might go:

```
@supports (display: grid) and (shape-outside: circle()) {  
    /* grid-and-shape styles go here */  
}
```

This is essentially equivalent to writing the following:

```
@supports (display: grid) {  
    @supports (shape-outside: circle()) {  
        /* grid-and-shape styles go here */  
    }  
}
```

```
}
```

However, there's more than "and" operations available. CSS shapes are a good example of why "or" is useful, because for a long time WebKit only supported them via vendor-prefixed properties. So if you want to use shapes, you can use a feature query like this:

```
@supports (shape-outside: circle()) {  
    (-webkit-shape-outside: circle()) {  
        /* shape styles go here */  
    }  
}
```

You'd still have to make sure to use both prefixed and unprefixed versions of the shape properties, but this would let you add support for those properties backward in the WebKit release line while supporting other browsers that also support shapes, but not via prefixed properties.

All this is incredibly handy because there are situations where you might want to apply different properties than those you're testing. So, to go back to grid layout for a second, you might want to change the margins and so forth on your layout elements when grid is in use. Here's a very simplified version of that approach:

```
div#main {overflow: hidden;}  
div.column {float: left; margin-right: 1em;}  
div.column:last-child {margin-right: 0;}  
  
@supports (display: grid) {  
    div#main {display: grid; grid-gap: 1em 0;  
              overflow: visible;}  
    div#main div.column {margin: 0;}  
}
```

It's possible to use negation as well. For example, you could apply the following styles in situations where grid layout is *not* supported:

```
@supports not (display: grid) {  
    /* grid-not-supported styles go here */  
}
```

You can combine your logical operators into a single query, but parentheses are required to keep the logic straight. Suppose we want a set of styles to be

allied when color is supported, and when one of either grid or flexbox display is supported. That's written like this:

```
@supports (color: black) and ((display: flex) or (display: grid))  
  /* styles go here */  
}
```

Notice how there's another set of parentheses around the "or" part of the logic, enclosing the grid and flex tests. Those extra parentheses are required; without them, the entire expression will fail, and the styles inside the block will be skipped. In other words, *don't* do this:

```
@supports (color: black) and (display: flex) or (display: grid) {
```

Finally, you might wonder why both a property and value are required in feature query tests. After all, if you're using shapes, all you need to test for is `shape-outside`, right? It's because a browser can easily support a property without supporting all its values. Grid layout is a perfect example for this. Suppose you could test for grid support like this:

```
@supports (display) {  
  /* grid styles go here */  
}
```

Well, even Internet Explorer 4 supported `display`. Any browser that understand `@supports` will certainly understand `display` and many of its values—but maybe not `grid`. That's why property and value are always tested in feature queries.

#### Warning

Remember that these are *feature* queries, not *correctness* queries. A browser can understand the feature you're testing for, but implement it with bugs. So you're not getting an assurance from the browser that it supports something correctly. All a positive feature-query result means is that the browser understands what you've said, and makes some sort of attempt to support it.

# Summary

With CSS, it is possible to completely change the way elements are presented by a user agent. This can be executed at a basic level with the `display` property, and in a different way by associating style sheets with a document. The user will never know whether this is done via an external or embedded style sheet, or even with an inline style. The real importance of external style sheets is the way in which they allow authors to put all of a site's presentation information in one place, and point all of the documents to that place. This not only makes site updates and maintenance a breeze, but it helps to save bandwidth since all of the presentation is removed from documents. With `@supports()`, it's even possible to do some basic progressive enhancement in native CSS.

To make the most of the power of CSS, authors need to know how to associate a set of styles with the elements in a document. To fully understand how CSS can do all of this, authors need a firm grasp of the way CSS selects pieces of a document for styling, which is the subject of the next chapter, “Selectors, Specificity, and the Cascade.”

# Chapter 13. Fonts

As the authors of CSS clearly recognized from the outset, font selection is a popular, indeed crucial, feature of web design. In fact, the beginning of the “Font Properties” section of the CSS1 specification begins with the sentence, “Setting font properties will be among the most common uses of style sheets.” The intervening years have done nothing to disprove this assertion.

CSS2 added the ability to specify custom fonts for download with `@font-face`, but it wasn’t until about 2009 that this capability really began to be widely and consistently supported. Now, websites can call on any font they have the right to use, aided by online services such as Typekit. Generally speaking, if you can get access to a font, you can use it in your design.

It’s important to remember, however, that this does not grant absolute control over fonts. If the font you’re using fails to download or is in a file format the user’s browser doesn’t understand, then the text will be displayed with a fallback font. That’s a good thing, since it means the user still gets your content, but it’s worth bearing in mind that you cannot absolutely depend on the presence of a given font, and should never design as if you can.

# Font Families

What we think of as a “font” is usually composed of many variations to describe bold text, italic text, and so on. For example, you’re probably familiar with (or at least have heard of) the font Times. However, Times is actually a combination of many variants, including TimesRegular, TimesBold, TimesItalic, TimesBoldItalic, and so on. Each of these variants of Times is an actual *font face*, and Times, as we usually think of it, is a combination of all these variant faces. In other words, Times is actually a *font family*, not just a single font, even though most of us think about fonts as being single entities.

In order to cover all the bases, CSS defines five generic font families:

## *Serif fonts*

These fonts are proportional and have serifs. A font is proportional if all characters in the font have different widths due to their various sizes. For example, a lowercase *i* and a lowercase *m* are different widths. (This book’s paragraph font is proportional, for example.) Serifs are the decorations on the ends of strokes within each character, such as little lines at the top and bottom of a lowercase *l*, or at the bottom of each leg of an uppercase *A*. Examples of serif fonts are Times, Georgia, and New Century Schoolbook.

## *Sans-serif fonts*

These fonts are proportional and do not have serifs. Examples of sans-serif fonts are Helvetica, Geneva, Verdana, Arial, and Univers.

## *Monospace fonts*

Monospace fonts are not proportional. These generally are used for displaying programmatic code or tabular data. In these fonts, each character uses up the same amount of horizontal space as all the others; thus, a lowercase *i* takes up the same horizontal space as a lowercase *m*,

even though their actual letterforms may have different widths. These fonts may or may not have serifs. If a font has uniform character widths, it is classified as monospace, regardless of the presence of serifs.

Examples of monospace fonts are Courier, Courier New, Consolas, and Andale Mono.

### *Cursive fonts*

These fonts attempt to emulate human handwriting or lettering. Usually, they are composed largely of flowing curves and have stroke decorations that exceed those found in serif fonts. For example, an uppercase *A* might have a small curl at the bottom of its left leg or be composed entirely of swashes and curls. Examples of cursive fonts are Zapf Chancery, Author, and Comic Sans.

### *Fantasy fonts*

Such fonts are not really defined by any single characteristic other than our inability to easily classify them in one of the other families (these are sometimes called “decorative” or “display” fonts). A few such fonts are Western, Woodblock, and Klingon.

In theory, every font family will fall into one of these generic families. In practice, this may not be the case, but the exceptions (if any) are likely to be few and far between, and browsers are likely to drop any fonts they cannot classify as serif, sans-serif, monospace, or cursive into the “fantasy” bucket.

# Using Generic Font Families

You can employ any font family available by using the property `font-family`.

## **font-family**

### *Values*

[ `<family-name>` | `<generic-family>`]# | `inherit`

### *Initial value*

User agent-specific

### *Applies to*

All elements

### *Inherited*

Yes

### *Computed value*

As specified

If you want a document to use a sans-serif font, but you do not particularly care which one, then the appropriate declaration would be:

```
body {font-family: sans-serif;}
```

This will cause the user agent to pick a sans-serif font family (such as Helvetica) and apply it to the `body` element. Thanks to inheritance, the same font family choice will be applied to all the elements that descend from the `body`—unless a more specific selector overrides it, of course.

Using nothing more than these generic families, an author can create a fairly sophisticated style sheet. The following rule set is illustrated in [Figure 13-1](#):

```
body {font-family: serif;}  
h1, h2, h3, h4 {font-family: sans-serif;}  
code, pre, tt, kbd {font-family: monospace;}  
p.signature {font-family: cursive;}
```

# An Ordinary Document

This is a mixture of elements such as you might find in a normal document. There are headings, paragraphs, `code` fragments, and many other inline elements. The fonts used for these various elements will depend on what the author has declared, and what the browser's default styles happen to be, and how the two interleave.

## A Section Title

Here we have some preformatted text  
just for the heck of it.

If you want to make changes to your startup script under DOS, you start by typing `edit autoexec.bat`. Of course, if you're running DOS, you probably already know that.

—*The Unknown Author*

**Figure 13-1.** Various font families

Thus, most of the document will use a serif font such as Times, including all paragraphs except those that have a `class` of `signature`, which will instead be rendered in a cursive font such as Author. Heading levels 1 through 4 will use a sans-serif font like Helvetica, while the elements `code`, `pre`, `tt`, and `kbd` will use a monospace font like Courier.

# Specifying a Font Family

An author may, on the other hand, have more specific preferences for which font to use in the display of a document or element. In a similar vein, a user may want to create a user style sheet that defines the exact fonts to be used in the display of all documents. In either case, `font-family` is still the property to use.

Assume for the moment that all `h1`s should use Georgia as their font. The simplest rule for this would be the following:

```
h1 {font-family: Georgia;}
```

This will cause the user agent displaying the document to use Georgia for all `h1`s, as shown in [Figure 13-2](#).

## A Level 1 Heading Element

**Figure 13-2.** An `h1` element using Georgia

Of course, this rule assumes that the user agent has Georgia available for use. If it doesn't, the user agent will be unable to use the rule at all. It won't ignore the rule, but if it can't find a font called "Georgia," it can't do anything but display `h1` elements using the user agent's default font (whatever that is).

All is not lost, however. By combining specific font names with generic font families, you can create documents that come out, if not exact, at least close to your intentions. To continue the previous example, the following markup tells a user agent to use Georgia if it's available, and to use another serif font if it's not.

```
h1 {font-family: Georgia, serif;}
```

If a reader doesn't have Georgia installed but does have Times, the user agent might use Times for `h1` elements. Even though Times isn't an exact match to Georgia, it's probably close enough.

For this reason, I strongly encourage you to always provide a generic family as part of any `font-family` rule. By doing so, you provide a fallback mechanism that lets user agents pick an alternative when they can't provide an exact font match. Here are a few more examples:

```
h1 {font-family: Arial, sans-serif;}  
h2 {font-family: Charcoal, sans-serif;}  
p {font-family: 'Times New Roman', serif;}  
address {font-family: Chicago, sans-serif;}
```

If you're familiar with fonts, you might have a number of similar fonts in mind for displaying a given element. Let's say that you want all paragraphs in a document to be displayed using Times, but you would also accept Times New Roman, Georgia, New Century Schoolbook, and New York (all of which are serif fonts) as alternate choices. First, decide the order of preference for these fonts, and then string them together with commas:

```
p {font-family: Times, 'Times New Roman', 'New Century Schoolbook  
'New York', serif;}
```

Based on this list, a user agent will look for the fonts in the order they're listed. If none of the listed fonts are available, then it will simply pick an available serif font.

## Using quotation marks

You may have noticed the presence of single quotes in the previous example, which we haven't seen before. Quotation marks are advisable in a `font-family` declaration only if a font name has one or more spaces in it, such as "New York," or if the font name includes symbols such as # or \$. Thus, a font called Karrank% should probably be quoted:

```
h2 {font-family: Wedgie, 'Karrank%', Klingon, fantasy;}
```

If you leave off the quotation marks, there is a chance that user agents will

ignore that particular font name altogether, although they'll still process the rest of the rule.

Note that the quoting of a font name containing a symbol is not actually required any more. Instead, it's recommended, which is as close to describing "best practices" as the CSS specification ever really gets. Similarly, it is recommended that you quote a font name containing spaces, though again, this is generally unnecessary in modern user agents. As it turns out, the only required quotation is for font names that match accepted `font-family` keywords. Thus, if you call for a font whose actual name is "cursive," you'll definitely need to quote it in order to distinguish it from the value keyword `cursive`:

```
h2 {font-family: Author, "cursive", cursive;}
```

Obviously, font names that use a single word (that doesn't conflict with any of the keywords for `font-family`) need not be quoted, and generic family names (`serif`, `monospace`, etc.) should never be quoted when they refer to the actual generic families. If you quote a generic name, then the user agent will assume that you are asking for a specific font with that name (for example, "serif"), not a generic family.

As for which quotation marks to use, both single and double quotes are acceptable. Remember that if you place a `font-family` rule in a `style` attribute, which you generally shouldn't, you'll need to use whichever quotes you didn't use for the attribute itself. Therefore, if you use double quotes to enclose the `font-family` rule, then you'll have to use single quotes within the rule, as in the following markup:

```
p {font-family: sans-serif;} /* sets paragraphs to sans-serif by
<!-- the next example is correct (uses single-quotes) --&gt;
&lt;p style="font-family: 'New Century Schoolbook', Times, serif;"&gt;.

<!-- the next example is NOT correct (uses double-quotes) --&gt;
&lt;p style="font-family: "New Century Schoolbook", Times, serif;"&gt;.</pre>
```

If you use double quotes in such a circumstance, they interfere with the attribute syntax, as you can see in [Figure 13-3](#).

This paragraph is supposed to use either 'New Century Schoolbook', Times, or an alternate serif font for its display.

This paragraph is also supposed to use either 'New Century Schoolbook', Times, or an alternate serif font for its display, but the quotation marks got unbalanced.

**Figure 13-3. The perils of incorrect quotation marks**

# Using @font-face

A feature that originally debuted in CSS2 but wasn't implemented until late in the first decade of the 2000s, `@font-face` lets you use custom fonts in your designs. While there's no guarantee that every last user will see the font you want, this feature is very widely supported and (as of early 2013) gaining a lot of currency in web design.

Suppose you want to use a very specific font in your style sheets, one that is not widely installed. Through the magic of `@font-face`, you can define a specific family name to correspond to a font file on your server. The user agent will download that file and use it to render the text in your page, the same as if it were installed on the user's machine. For example:

```
@font-face {  
    font-family: "SwitzeraADF";  
    src: url("SwitzeraADF-Regular.otf");  
}
```

This allows the author to have conforming user agents load the defined `.otf` file and use that font to render text when called upon via `font-family`: `SwitzeraADF`.

## Note

The examples in this section refer to SwitzeraADF, a font face collection available from the [Arkandis Digital Foundry](#).

The intent of `@font-face` is to allow “lazy loading” of font faces. This means that only those faces needed to render a document will actually be loaded, with the rest being left alone. In fact, a browser that downloads all declared font faces without considering whether they're actually needed is considered to be buggy.

# Required Descriptors

All the parameters that define the font you're referencing are contained within the `@font-face { }` construct. These are called *descriptors*, and very much like properties, they take the format `descriptor: value;`. In fact, most of the descriptor names refer directly to property names, as will be explained in just a moment.

There are two required descriptors: `font-family` and `src`.

## **font-family**

*Value*

`<family-name>`

*Initial value*

Not defined

## **src**

*Values*

`[ [ <uri> [format(<string>)]? ] | <font-face-name> ]`

*Initial value*

Not defined

The point of `src` is pretty straightforward: it lets you define one or more sources for the font face you're defining, using a comma-separated list if there are in fact multiple sources. You can point to a font face at any URI, but there is a restriction: font faces can only be loaded from the same origin as the style sheet. Thus, you can't point your `src` at someone else's site and download their font; you'll need to host a local copy on your own server, or

use a font-hosting service that provides both the style sheet(s) and the font file(s).

**Note**

There is an exception to the same-origin restriction, which is that servers can permit cross-site loading using the HTTP header `Access-Control-Allow-Origin`.

You may well be wondering how it is that we're defining `font-family` here when it was already defined in a previous section. The difference is that this `font-family` is the *font-family descriptor*, and the previously-defined `font-family` was the *font-family property*. If that seems confusing, stick with me a moment and all should become clear.

In effect, `@font-face` lets you create low-level definitions that underpin the font-related properties like `font-family`. When you define a font family name via the descriptor `font-family: "SwitzeraADF";`, you're setting up an entry in the user agent's table of font families for "SwitzeraADF." It thus joins all the usual suspects like Helvetica, Georgia, Courier, and so forth, as a font you can just refer to in your `font-family` property values.

```
@font-face {  
    font-family: "SwitzeraADF"; /* descriptor */  
    src: url("SwitzeraADF-Regular.otf");  
}  
h1 {font-family: SwitzeraADF, Helvetica, sans-serif;} /* property
```

Note how the `font-family` descriptor value and the entry in the `font-family` property match. If they didn't match, then the `h1` rule would ignore the first font family name listed in the `font-family` value and move on to the next. As long as the font has cleanly downloaded and is in a format the user agent can handle, then it will be used in the manner you direct, as illustrated in [Figure 13-4](#).

# A Level 1 Heading Element

This is a paragraph, and as such uses the browser's default font (because there are no other author styles being applied to this document). This is usually, as it is here, a serif font of some variety.

**Figure 13-4. Using a downloaded font**

In a similar manner, the comma-separated `src` descriptor value provides fallbacks. That way, if (for whatever reason) the user agent is unable to download the first source, it can fall back to the second source and try to load the file there.

```
@font-face {  
    font-family: "SwitzeraADF";  
    src: url("SwitzeraADF-Regular.otf"),  
         url("/fonts/SwitzeraADF-Regular.otf");  
}
```

Remember that the same-origin policy generally applies in this case, so pointing to a copy of the font some other server will usually fail, unless of course said server is set up to permit cross-origin access.

If you want to be sure the user agent understands what kind of font you're telling it to use, that can be done with the optional `format()`.

```
@font-face {  
    font-family: "SwitzeraADF";  
    src: url("SwitzeraADF-Regular.otf") format("opentype");  
}
```

The advantage of supplying a `format()` description is that user agents can skip downloading files in formats that they don't support, thus reducing bandwidth use and loading speed. It also lets you explicitly declare a format for a file that might not have a common filename extension and thus be unfamiliar to the user agent.

```
@font-face {  
    font-family: "SwitzeraADF";
```

```
src: url("SwitzeraADF-Regular.otf") format("opentype"),
      url("SwitzeraADF-Regular.true") format("truetype");
}
```

## The Flash

If you're a designer or developer of a certain vintage, you may remember the days of FOUC: the Flash of Unstyled Content. This happened in earlier browsers that would load the HTML and display it to the screen before the CSS was finished loading, or at least before the layout of the page via CSS was finished. Thus, what would appear was a split-second of "plain ol' text" (using the browser's default styles) before it was replaced with the CSS-decorated layout.

As of early 2013, there is a cousin to this problem, which is the Flash of UnFonted Text, or FOUFT. This happens when a browser has loaded the page and the CSS and displays the laid-out page before it's done loading custom fonts. This causes text to appear in the default font, or a fallback font, before being replaced by text using the custom-loaded font.

Since the replacement of text with the custom-loaded font face can change its layout size, authors should take care in selecting fallback fonts. If there is a significant height difference between the font used to initially display the text and the custom font eventually loaded and used, significant page reflows are likely to occur. There's no automated way to enforce this, though `font-size-adjust` (covered later) can help. You simply have to look at your intended font and find other faces that have a similar height.

The core reason for the "flash" behavior is pretty much the same now as it was then: the browser is ready to show something before it has all the resources on hand, so it goes ahead and does so, replacing it with the prettier version once it can. The FOUC was eventually solved, and it's likely that some day we'll look back at the FOUFT the same way we do at the FOUC now. Until then, we'll have to take comfort in the fact that the FOUFT isn't usually as jarring as was the FOUC.

[Table 13-1](#) lists all of the allowed format values (as of early 2013).

Table 13-1 Recognized font format values

Table 15-1. Recognized font format values

Value	Format
embedded-opentype	EOT (Embedded OpenType)
opentype	OTF (OpenType)
svg	SVG (Scalable Vector Graphics)
truetype	TTF (TrueType)
woff	WOFF (Web Open Font Format)

In addition to the combination of `url()` and `format()`, you can also supply a font family name (or several names) in case the font is already locally available on the user's machine, using the aptly-named `local()`.

```
@font-face {  
    font-family: "SwitzenaADF";  
    src: local("Switzena-Regular"),  
         local("SwitzenaADF-Regular "),  
         url("SwitzenaADF-Regular.otf") format("opentype"),  
         url("SwitzenaADF-Regular.true") format("truetype");  
}
```

In this example, the user agent looks to see if it already has a font family named “Switzena-Regular” or “SwitzenaADF-Regular” available. If so, it will use the name `SwitzenaADF` to refer to that locally installed font. If not, it will use the `url()` value to try downloading the remote font.

Note that this capability allows an author to create custom names for locally installed fonts. For example, you could set up a shorter name for Helvetica (or, failing that, Helvetica Neue) like so:

```
@font-face {
```

```

    font-family: "H";
    src: local("Helvetica"),
         local("Helvetica Neue");
}

h1, h2, h3 {font-family: H, sans-serif;}

```

As long as the user has Helvetica installed on their machine, then those rules will cause the first three heading levels to be rendered using Helvetica. It seems a little gimmicky, but it could have a real impact on reducing style sheet file size in certain situations.

## On Being Bulletproof

The tricky part with `@font-face` is that different browsers of different eras supported different font formats. (To the insider, [Table 13-1](#) reads as a capsule history of downloadable font support.) In order to cover the widest possible landscape, you should turn to what is known as the “Bulletproof `@font-face` Syntax.” Initially developed by Paul Irish and refined by the chaps at FontSpring, it looks like this:

```

@font-face {
    font-family: "SwitzeraADF";
    src: url("SwitzeraADF-Regular.eot");
    src: url("SwitzeraADF-Regular.eot?#iefix") format("embedded-o
          url("SwitzeraADF-Regular.woff") format("woff"),
          url("SwitzeraADF-Regular.ttf") format("truetype"),
          url("SwitzeraADF-Regular.svg#switzena_adf_regular") form
}

```

Let’s break it down piece by piece. The first bit, assigning the `font-family` name, is straightforward enough. After that, we see:

```

src: url("SwitzeraADF-Regular.eot");
src: url("SwitzeraADF-Regular.eot?#iefix") format("embedded-o

```

This supplies an EOT (Embedded OpenType) to browsers that understand only EOTs—IE6 through IE9. The first line is for IE9 when it’s in “Compatibility Mode,” and the second line hands the same file to IE6-IE8. The `?#iefix` bit in that line exploits a parsing bug in those browsers to step around another parsing bug that causes them to 404 any `@font-face` with

multiple formats listed. IE9 fixed its bugs without expanding its font formats, so the first line is what lets it join the party.

```
url("SwitzeraADF-Regular.woff") format("woff"),
```

This line supplies a Web Open Font Format file to browsers that understand it, which includes most modern browsers. At this point, in fact, you'll have covered the vast majority of your desktop users.

```
url("SwitzeraADF-Regular.ttf") format("truetype"),
```

This line hands over the file format understood by most iOS and Android devices, thus covering most of your handheld users.

```
url("SwitzeraADF-Regular.svg#switzera_adf_regular") format("svg")
```

Here, at the end, we supply the only font format understood by old iOS devices. This covers almost all of your remaining handheld users.

Obviously, this gets a bit unwieldy if you're specifying more than a couple of faces, and typing it in even once is kind of a pain in the wrists. Fortunately, there are services available that will accept your font faces and generate all the `@font-face` rules you need, convert those faces to all the formats required, and hand it all back to you as a single package. One of the best is [Font Squirrel's “@Font-Face Kit Generator”](#). Just make sure you're legally able to convert and use the font faces you're running through the generator (see the next sidebar, [“Custom Font Considerations”](#), for more information).

# Other Font Descriptors

In addition to the required `font-family` and `src` descriptors, there are a number of optional descriptors that can be used to associate font faces with specific font property values. Just as with `font-family`, these descriptors (summarized in [Table 13-2](#)) correspond directly to CSS properties (explained in detail later in this chapter) and affect how user agents respond to the values supplied for those properties.

## Custom Font Considerations

There are two things you need to keep in mind when using customized fonts. The first is that you have the rights to use the font in a web page, and the second is whether it's a good idea to do so.

Much like stock photography, font families come with licenses that govern their use, and not every font license permits its use on the web. You can completely avoid this question by only using FOSS (Free and Open-Source Software) fonts only, or by using a commercial service like Fontdeck or Typekit that will deal with the licensing and format conversion issues so you don't have to. Otherwise, you need to make sure that you have the right to use a font face in the way you want to use it, just the same as you would make sure you had the proper license for any images you bought.

In addition, the more font faces you call upon, the more resources the web server has to hand over and the higher the overall page weight will become. Most faces are not overly large—usually 50K to 100K—but they add up quickly if you decide to get fancy with your type, and truly complicated faces can be larger. Of course, the same problems exist for images. As always, you will have to balance appearance against performance, leaning one way or the other depending on the circumstances. Furthermore, just as there are image optimization tools available, there are also font optimization tools. Typically these are “subsetting” tools, which construct fonts using only the symbols actually needed for display. If you’re using a service like Typekit or [Fonts.com](#), they probably have subsetting tools available, or do it

dynamically when the font is requested.

Table 13-2. Font descriptors

Descriptor	Default value	Description
font-style	normal	Distinguishes between normal, italic, and oblique faces
font-weight	normal	Distinguishes between various weights (e.g., bold)
font-stretch	normal	Distinguishes between varying degrees of character widths (e.g., condensed and expanded)
font-variant	normal	Distinguishes between a staggeringly wide range of potential variant faces (e.g., small-caps); in most ways, a more “CSS-like” version of <code>font-feature-settings</code>
font-feature-settings	normal	Permits direct access to low-level OpenType features (e.g., enabling ligatures)
unicode-range	U+0–10FFFF	Defines the range of characters for which a given face may be used

Because these font descriptors are optional, they may not be listed in a `@font-face` rule, but CSS does not allow descriptors to go without default values any more than it does for properties. If an optional descriptor is omitted, then it is set to the default value. Thus, if `font-weight` is not listed, the default value of `normal` is assumed.

## Restricting Character Range

There is one font descriptor, `unicode-range`, which (unlike the others in [Table 13-2](#)) has no corresponding CSS property. This descriptor allows authors to define the range of characters to which a custom font can be applied. This can be useful when using a symbol font, or to ensure that a font face is only applied to characters that are in a specific language.

## **unicode-range**

*Values*

`<urange>#`

*Initial value*

`U+0-10FFFF`

By default, the value of this property covers the entirety of Unicode, meaning that if a font can supply the glyph for a character, it will. Most of the time, this is exactly what you want. For all the other times, you'll want to use a specific font face for a specific kind of content. To pick two examples from the CSS Fonts Module Level 3:

```
unicode-range: U+590-5FF; /* Hebrew characters */  
unicode-range: U+4E00-9FFF, U+FF00-FF9F, U+30??; /* Japanese kan
```

In the first case, a single range is specified, spanning Unicode character code point 590 through code point 5FF. This covers the characters used in Hebrew. Thus, an author might specify a Hebrew font and restrict it to only be used for Hebrew characters, even if the face contains glyphs for other code points:

```
@font-face {  
    font-family: "CMM-Ahuvhah";  
    src: url("cmm-ahuvhah.otf") format("opentype");  
    unicode-range: U+590-5FF;  
}
```

In the second case, a series of ranges are specified in a comma-separated list to cover all the Japanese characters. The interesting feature there is the `U+30??` value, which is a special format permitted in `unicode-range` values.

The question marks are wildcards meaning “any possible digit,” making U+30?? equivalent to U+3000–30FF. The question mark is the only “special” character pattern permitted in the value.

Ranges must always ascend. Any descending range (e.g., U+400–300) is treated as a parsing error and ignored. Besides ranges, you can also declare a single code point, which looks like U+221E. This is most often useful in conjunction with other code points and ranges, like so:

```
unicode-range: U+4E00-9FFF, U+FF00-FF9F, U+30??, U+A5;  
/* Japanese kanji, hiragana, and katakana, plus yen/yuan curren
```

Of course, you could use a single code point to declare that a specific face only be used to render one, and only one, character. Whether or not that’s a good idea is left to you, your design, the size of the font file, and your users’ connection speeds.

Because @font-face is designed for “lazy loading” optimization, it’s possible to use unicode-range to download only the font faces a page actually needs. Suppose that you have a website that uses a mixture of English, Russian, and basic mathematical operators, but you don’t know which will appear on any given page. There could be all English, a mixture of Russian and math, and so on. Furthermore, suppose you have special font faces for all three types of content. You can make sure a user agent only downloads the faces it actually needs with a properly-constructed series of @font-face rules.

```
@font-face {  
    font-family: "MyFont";  
    src: url("myfont-general.otf") format("opentype");  
}  
@font-face {  
    font-family: "MyFont";  
    src: url("myfont-cyrillic.otf") format("opentype");  
    unicode-range: U+04??, U+0500-052F, U+2DE0-2DFF, U+A640-A69F,  
}  
@font-face {  
    font-family: "MyFont";  
    src: url("myfont-math.otf") format("opentype");  
    unicode-range: U+22??; /* equivalent to U+2200-22FF */  
}
```

Because the first rule doesn't specify a Unicode range, it is always downloaded—unless, of course, a page happens to contain no characters at all (and maybe even then). The second rule causes `myfont-cyrillic.otf` to be downloaded only if the page contains characters in its declared Unicode range; the third rule does the same for basic mathematical operators.

**Note**

As of mid-2013, the only user agent line to support `unicode-range` was the Webkit family.

# Combining Descriptors

Something that might not be immediately obvious is that you can supply multiple descriptors in order to assign specific faces for specific property combinations. For example, you can assign one face to bold text, another to italic text, and a third to text that is both bold and italic.

This is actually implicit in the fact that any undeclared descriptor is assigned its default value. Let's consider a basic set of three face assignments:

```
@font-face {  
    font-family: "SwitzeraADF";  
    font-weight: normal;  
    font-style: normal;  
    font-stretch: normal;  
    src: url("SwitzeraADF-Regular.otf") format("opentype");  
}  
@font-face {  
    font-family: "SwitzeraADF";  
    font-weight: bold;  
    font-style: normal;  
    font-stretch: normal;  
    src: url("SwitzeraADF-Bold.otf") format("opentype");  
}  
@font-face {  
    font-family: "SwitzeraADF";  
    font-weight: normal;  
    font-style: italic;  
    font-stretch: normal;  
    src: url("SwitzeraADF-Italic.otf") format("opentype");  
}
```

Here, we've made the implicit explicit: any time a descriptor isn't being altered, its default value is listed. This is exactly the same as a set of three rules in which we remove every descriptor that shows a value of `normal`:

```
@font-face {  
    font-family: "SwitzeraADF";  
    src: url("SwitzeraADF-Regular.otf") format("opentype");  
}  
@font-face {
```

```

font-family: "SwitzeraADF";
font-weight: bold;
src: url("SwitzeraADF-Bold.otf") format("opentype");
}
@font-face {
    font-family: "SwitzeraADF";
    font-style: italic;
    src: url("SwitzeraADF-Italic.otf") format("opentype");
}

```

In all three rules, there is no font-stretching beyond the normal amount, and the values of `font-weight` and `font-style` vary by which face is being assigned. So what if we want to assign a specific face to unstretched text that's both bold and italic?

```

@font-face {
    font-family: "SwitzeraADF";
    font-weight: bold;
    font-style: italic;
    font-stretch: normal;
    src: url("SwitzeraADF-BoldItalic.otf") format("opentype");
}

```

And then what about bold, italic, condensed text?

```

@font-face {
    font-family: "SwitzeraADF";
    font-weight: bold;
    font-style: italic;
    font-stretch: condensed;
    src: url("SwitzeraADF-BoldCondItalic.otf") format("opentype");
}

```

How about normal-weight, italic, condensed text?

```

@font-face {
    font-family: "SwitzeraADF";
    font-weight: normal;
    font-style: italic;
    font-stretch: condensed;
    src: url("SwitzeraADF-CondItalic.otf") format("opentype");
}

```

We could keep this up for quite a while, but let's stop there. If we take all those rules and strip out anything with a `normal` value, we end up with this

result, illustrated in [Figure 13-5](#):

```
@font-face {  
    font-family: "SwitzeraADF";  
    src: url("SwitzeraADF-Regular.otf") format("opentype");  
}  
@font-face {  
    font-family: "SwitzeraADF";  
    font-weight: bold;  
    src: url("SwitzeraADF-Bold.otf") format("opentype");  
}  
@font-face {  
    font-family: "SwitzeraADF";  
    font-style: italic;  
    src: url("SwitzeraADF-Italic.otf") format("opentype");  
}  
@font-face {  
    font-family: "SwitzeraADF";  
    font-weight: bold;  
    font-style: italic;  
    src: url("SwitzeraADF-BoldItalic.otf") format("opentype");  
}  
@font-face {  
    font-family: "SwitzeraADF";  
    font-weight: bold;  
    font-stretch: condensed;  
    src: url("SwitzeraADF-BoldCond.otf") format("opentype");  
}  
@font-face {  
    font-family: "SwitzeraADF";  
    font-style: italic;  
    font-stretch: condensed;  
    src: url("SwitzeraADF-CondItalic.otf") format("opentype");  
}  
@font-face {  
    font-family: "SwitzeraADF";  
    font-weight: bold;  
    font-style: italic;  
    font-stretch: condensed;  
    src: url("SwitzeraADF-BoldCondItalic.otf") format("opentype");  
}
```

This element contains serif text, unstretched **bold** and *italic* text in SwitzeraADF, and unstretched ***bold and italic*** text in SwitzeraADF.

This element contains serif text, condensed **bold** and *italic* text in SwitzeraADF, and condensed ***bold and italic*** text in SwitzeraADF.

**Figure 13-5. Employing a variety of faces**

As you can see, there are a lot of possible combinations just for those three descriptors—consider that there are eleven possible values for `font-weight`, and ten for `font-stretch`—but you'll likely never have to run through them all. In fact, most font families don't have as many faces as SwitzeraADF offers (24 at last count) so there wouldn't be much point in writing out all the possibilities. Nevertheless, the options are there, and in some cases you may find that you need to assign, say, a specific face for bold condensed text so that the user agent doesn't try to compute them for you.

# Font Weights

Now that we've covered `@font-face` and its descriptors, let's get back to properties. We're all used to normal and bold text, at the very least, which are sort of the two most basic font weights available. CSS gives you a lot more control over font weights with the property `font-weight`.

## **font-weight**

### *Values*

`normal | bold | bolder | lighter | 100 | 200 | 300 | 400 | 500 | 600 | 700 |  
800 | 900 | inherit`

### *Initial value*

`normal`

### *Applies to*

All elements

### *Inherited*

Yes

### *Computed value*

One of the numeric values (100, etc.), or one of the numeric values plus one of the relative values (`bolder` or `lighter`)

### *Note*

Has a corresponding `@font-face` descriptor (see below)

Generally speaking, the heavier a font weight becomes, the darker and “more

bold” a font appears. There are a great many ways to label a heavy font face. For example, the font family known as SwitzeraADF has a number of variants, such as SwitzeraADF Bold, SwitzeraADF Extra Bold, SwitzeraADF Light, and SwitzeraADF Regular. All of these use the same basic font shapes, but each has a different weight.

So let’s say that you want to use SwitzeraADF for a document, but you’d like to make use of all those different heaviness levels. You could refer to them directly through the `font-family` property, but you really shouldn’t have to do that. Besides, it’s no fun having to write a style sheet like this:

```
h1 {font-family: 'SwitzeraADF Extra Bold', sans-serif;}  
h2 {font-family: 'SwitzeraADF Bold', sans-serif;}  
h3 {font-family: 'SwitzeraADF Bold', sans-serif;}  
h4, p {font-family: SwitzeraADF Regular, sans-serif;}  
small {font-family: 'SwitzeraADF Light', sans-serif;}
```

That’s pretty tedious. It would make far more sense to specify a single font family for the whole document and then assign different weights to various elements. You can do this via `@font-face` and use the various values for the property `font-weight`. This is a fairly obvious `font-weight` declaration:

```
b {font-weight: bold;}
```

This declaration says, simply, that the `b` element should be displayed using a bold font face; or, to put it another way, a font face that is heavier than the normal font face. This is what we’re used to, of course, since `b` does cause text to be bold.

What’s really happening behind the scenes is that a heavier face of the font is used for displaying a `b` element. Thus, if you have a paragraph displayed using Times, and part of it is bold, then there are really two faces of the same font in use: Times and TimesBold. The regular text is displayed using Times, and the bold text is displayed using TimesBold.

# How Weights Work

To understand how a user agent determines the heaviness, or weight, of a given font variant (not to mention how weight is inherited), it's easiest to start by talking about the keywords `100` through `900`. These number keywords were defined to map to a relatively common feature of font design in which a font is given nine levels of weight. If a font family has faces for all nine weight levels available, then the numbers are mapped directly to the predefined levels, with `100` as the lightest variant of the font and `900` as the heaviest.

In fact, there is no intrinsic weight in these numbers. The CSS specification says only that each number corresponds to a weight at least as heavy as the number that precedes it. Thus, `100`, `200`, `300`, and `400` might all map to the same relatively lightweight variant; `500` and `600` could correspond to the same heavier font variant; and `700`, `800`, and `900` could all produce the same very heavy font variant. As long as no keyword corresponds to a variant that is lighter than the variant assigned to the previous keyword, everything will be all right.

As it happens, these numbers are defined to be equivalent to certain common variant names, not to mention other values for `font-weight`. `400` is defined to be equivalent to `normal`, and `700` corresponds to `bold`. The other numbers do not match up with any other values for `font-weight`, but they can correspond to common variant names. If there is a font variant labeled something such as “Normal,” “Regular,” “Roman,” or “Book,” then it is assigned to the number `400` and any variant with the label “Medium” is assigned to `500`. However, if a variant labeled “Medium” is the only variant available, it is assigned to `400` instead of `500`.

A user agent has to do even more work if there are fewer than nine weights in a given font family. In this case, it must fill in the gaps in a predetermined way:

- If the value `500` is unassigned, it is given the same font weight as that

assigned to 400.

- If 300 is unassigned, it is given the next variant lighter than 400. If no lighter variant is available, 300 is assigned the same variant as 400. In this case, it will usually be “Normal” or “Medium.” This method is also used for 200 and 100.
- If 600 is unassigned, it is given the next variant darker than that assigned for 500. If no darker variant is available, 600 is assigned the same variant as 500. This method is also used for 700, 800, and 900.

To illustrate this weighting scheme more clearly, let’s look at three examples of font weight assignment. In the first example, assume that the font family Karrank% is an OpenType font, so it has nine weights already defined. In this case, the numbers are assigned to each level, and the keywords `normal` and `bold` are assigned to the numbers 400 and 700, respectively. This is the most straightforward example, and therefore the one that almost never occurs in the real world. (It is quite rare for a font family to have nine weight levels, and those that do are usually very expensive.)

In our second example, consider the font family SwitzeraADF, which was discussed near the beginning of this section. Hypothetically, its variants might be assigned numeric values for `font-weight`, as shown in [Table 13-3](#).

Table 13-3. Hypothetical weight assignments for a specific font family

Font face	Assigned keyword	Assigned number(s)
SwitzeraADF Light		100, 200, 300
SwitzeraADF Regular	normal	400
SwitzeraADF Medium		500
SwitzeraADF Bold	bold	600, 700

SwitzeraADF Extra Bold	800, 900
------------------------	----------

The first three number values are assigned to the lightest weight. The “Regular” face gets the keyword `normal`, as expected, and the number weight 400. Since there is a “Medium” font, it’s assigned to the number 500. There is nothing to assign to 600, so it’s mapped to the “Bold” font face, which is also the variant to which 700 and `bold` are assigned. Finally, 800 and 900 are assigned to the “Black” and “UltraBlack” variants, respectively. Note that this last assignment would happen only if those faces had the top two weight levels already assigned. Otherwise, the user agent might ignore them and assign 800 and 900 to the “Bold” face instead, or it might assign them both to one or the other of the “Black” variants.

For our third and final example, let’s consider a stripped-down version of Times. In [Table 13-4](#), there are only two weight variants: “TimesRegular” and “TimesBold.”

Table 13-4. Hypothetical weight assignments for “Times”

Font face	Assigned keyword	Assigned numbers
-----------	------------------	------------------

TimesRegular	<code>normal</code>	100, 200, 300, 400, 500
--------------	---------------------	-------------------------

TimesBold	<code>bold</code>	600, 700, 800, 900
-----------	-------------------	--------------------

The assignment of the keywords `normal` and `bold` is straightforward enough, of course. As for the numbers, 100 through 300 are assigned to the “Regular” face because there isn’t a lighter face available. 400 is assigned to “Regular” as expected, but what about 500? It is assigned to the “Regular” (or `normal`) face because there isn’t a “Medium” face available; thus, it is assigned the same font face as 400. As for the rest, 700 goes with `bold` as always, while 800 and 900, lacking a heavier face, are assigned to the next-lighter face, which is the “Bold” font face. Finally, 600 is assigned to the next-heavier face, which is, of course, the “Bold” face.

`font-weight` is inherited, so if you set a paragraph to be `bold`:

```
p.one {font-weight: bold;}
```

...then all of its children will inherit that boldness, as we see in [Figure 13-6](#).

Within this paragraph we find some *italicized text*, a bit of underlined text, and the occasional stretch of [hyperlinked text](#) for our viewing pleasure.

**Figure 13-6. Inherited font-weight**

This isn't unusual, but the situation gets interesting when you use the last two values we have to discuss: `bolder` and `lighter`. In general terms, these keywords have the effect you'd anticipate: they make text more or less bold compared to its parent's font weight. First, let's consider `bolder`.

# Getting Bolder

If you set an element to have a weight of `bolder`, then the user agent first must determine what `font-weight` value was inherited from the parent element. It then selects the lowest number which corresponds to a font weight darker than what was inherited. If none is available, then the user agent sets the element's font weight to the next numerical value, unless the value is already `900`, in which case the weight remains at `900`. Thus, you might encounter the following situations, illustrated in [Figure 13-7](#):

```
p {font-weight: normal;}  
p em {font-weight: bolder;} /* results in bold text, evaluates to  
  
h1 {font-weight: bold;}  
h1 b {font-weight: bolder;} /* if no bolder face exists, evaluates to  
  
div {font-weight: 100;} /* assume 'Light' face exists; see explanation  
div strong {font-weight: bolder;} /* results in normal text, weig
```

Within this paragraph we find some *emphasized text*.

## This H1 contains bold text!

Meanwhile, this DIV element has some strong text but it shouldn't look much different, at least in terms of font weight.

**Figure 13-7. Text trying to be bolder**

In the first example, the user agent moves up the weight ladder from `normal` to `bold`; in numeric terms, it jumps from `400` to `700`. In the second example, `h1` text is already set to `bold`. If there is no bolder face available, then the user agent sets the weight of `b` text within an `h1` to `800`, since that is the next step up from `700` (the numeric equivalent of `bold`). Since `800` is assigned to the same font face as `700`, there is no visible difference between normal `h1` text and bold `h1` text, but the weights are different nonetheless.

In the last example, paragraphs are set to be the lightest possible font weight, which we assume exists as a “Light” variant. Furthermore, the other faces in this font family are “Regular” and “Bold.” Any `em` text within a paragraph will evaluate to `normal` since that is the next-heaviest face within the font family. However, what if the only faces in the font are “Regular” and “Bold”? In that case, the declarations would evaluate like this:

```
/* assume only two faces for this example: 'Regular' and 'Bold'  
p {font-weight: 100;} /* looks the same as 'normal' text */  
p span {font-weight: bolder;} /* maps to '700' */
```

As you can see, the weight `100` is assigned to the `normal` font face, but the value of `font-weight` is still `100`. Thus, any `span` text that is descended from a `p` element will inherit the value of `100` and then evaluate to the next-heaviest face, which is the “Bold” face with a numerical weight of `700`.

Let’s take this one step further and add two more rules, plus some markup, to illustrate how all of this works (see [Figure 13-8](#) for the results):

```
/* assume only two faces for this example: 'Regular' and 'Bold'  
p {font-weight: 100;} /* looks the same as 'normal' text */  
p span {font-weight: 400;} /* so does this */  
strong {font-weight: bolder;} /* even bolder than its parent */  
strong b {font-weight: bolder;} /*bolder still */
```

`<p>`

This paragraph contains elements of increasing weight: there is a `<span>` element that contains a `<strong>` element and a `<b>` element.

`</p>`

This paragraph contains elements of increasing weight: there is an *emphasized element* which contains a **strongly emphasized element**, and that contains a **bold element**.

**Figure 13-8. Moving up the weight scale**

In the last two nested elements, the computed value of `font-weight` is increased because of the liberal use of the keyword `bolder`. If you were to replace the text in the paragraph with numbers representing the `font-weight` of each element, you would get the results shown here:

```
<p>
100 <span> 400 <strong> 700 <b> 800 </b> </strong> </span>.
</p>
```

The first two weight increases are large because they represent jumps from 100 to 400 and from 400 to bold (700). From 700, there is no heavier face, so the user agent simply moves the value of `font-weight` one notch up the numeric scale (800). Furthermore, if you were to insert a `strong` element into the `b` element, it would come out like this:

```
<p>
100 <span> 400 <strong> 700 <b> 800 <strong> 900
</strong> </b> </strong> </span>.
</p>
```

If there were yet another `b` element inserted into the innermost `strong` element, its weight would also be 900, since `font-weight` can never be higher than 900. Assuming that there are only two font faces available, then the text would appear to be either Regular or Bold, as you can see in [Figure 13-9](#):

```
<p>
regular <span> regular <strong> bold <b> bold <strong> bold </str
</strong> </span>.
</p>
```

100 400 700 800 .

**Figure 13-9.** Visual weight, with descriptors

# Lightening Weights

As you might expect, `lighter` works in just the same way, except it causes the user agent to move down the weight scale instead of up. With a quick modification of the previous example, you can see this very clearly:

```
/* assume only two faces for this example: 'Regular' and 'Bold'  
p {font-weight: 900;} /* as bold as possible, which will look '  
p span {font-weight: 700;} /* this will also be bold */  
strong {font-weight: lighter;} /* lighter than its parent */  
b {font-weight: lighter;} /* lighter still */  
  
<p>  
900 <span> 700 <strong> 400 <b> 300 <strong> 200  
</strong> </b> </strong> </span>.  
</p>  
<!-- ...or, to put it another way... -->  
<p>  
bold <span> bold <strong> regular <b> regular <strong> regular </  
</strong></span>.  
</p>
```

Ignoring the fact that this would be entirely counterintuitive, what you see in [Figure 13-10](#) is that the main paragraph text has a weight of `900`. When the `strong` text is set to be `lighter`, it evaluates to the next-lighter face, which is the `regular` face, or `400` (the same as `normal`) on the numeric scale. The next step down is to `300`, which is the same as `normal` since no lighter faces exist. From there, the user agent can reduce the weight only one numeric step at a time until it reaches `100` (which it doesn't do in the example). The second paragraph shows which text will be `bold` and which will be `regular`.

**900 700 400 300 200 .**

**Figure 13-10.** Making text lighter

## The font-weight Descriptor

With the `font-weight` descriptor, authors can assign faces of varying weights

to the weighting levels permitted by the `font-weight` property. For example, the following rules explicitly assign five faces to six different `font-weight` values:

```
@font-face {  
    font-family: "SwitzeraADF";  
    font-weight: normal;  
    src: url("f/SwitzeraADF-Regular.otf") format("opentype");  
}  
@font-face {  
    font-family: "SwitzeraADF";  
    font-weight: bold;  
    src: url("f/SwitzeraADF-Bold.otf") format("opentype");  
}  
@font-face {  
    font-family: "SwitzeraADF";  
    font-weight: 300;  
    src: url("f/SwitzeraADF-Light.otf") format("opentype");  
}  
@font-face {  
    font-family: "SwitzeraADF";  
    font-weight: 500;  
    src: url("f/SwitzeraADF-DemiBold.otf") format("opentype");  
}@font-face {  
    font-family: "SwitzeraADF";  
    font-weight: 700;  
    src: url("f/SwitzeraADF-Bold.otf") format("opentype");  
}  
@font-face {  
    font-family: "SwitzeraADF";  
    font-weight: 900;  
    src: url("f/SwitzeraADF-ExtraBold.otf") format("opentype");  
}
```

With these faces assigned, the author now has a number of weighting levels available for his use, as illustrated in [Figure 13-11](#):

```
h1, h2, h3, h4 {font: 225% SwitzeraADF, Helvetica, sans-serif;}  
h1 {font-weight: 900;}  
h2 {font-size: 180%; font-weight: 700;}  
h3 {font-size: 150%; font-weight: 500;}  
h4 {font-size: 125%; font-weight: 300;}
```

# A Level 1 Heading Element

## A Level 2 Heading Element

### A Level 3 Heading Element

#### A Level 4 Heading Element

**Figure 13-11.** Using declared font-weight faces

In any given situation, the user agent picks which face to use depending on the exact value of a `font-weight` property, using the resolution algorithm detailed earlier in this section. Authors may use any value for the `font-weight` descriptor that is permitted for the `font-weight` property *except* the `inherit` keyword.

# Font Size

The methods for determining font size are both very familiar and very different.

## **font-size**

### *Values*

`xx-small | x-small | small | medium | large | x-large | xx-large |  
smaller | larger | <length> | <percentage> | inherit`

### *Initial value*

`medium`

### *Applies to*

All elements

### *Inherited*

Yes

### *Percentages*

Calculated with respect to the parent element's font size

### *Computed value*

An absolute length

In a fashion very similar to the `font-weight` keywords `bolder` and `lighter`, the property `font-size` has relative-size keywords called `larger` and `smaller`. Much like what we saw with relative font weights, these keywords cause the computed value of `font-size` to move up and down a scale of size

values, which you'll need to understand before you can explore larger and smaller. First, though, we need to examine how fonts are sized in the first place.

In fact, the actual relation of the `font-size` property to what you see rendered is determined by the font's designer. This relationship is set as an *em square* (some call it an *em box*) within the font itself. This em square (and thus the font size) doesn't have to refer to any boundaries established by the characters in a font. Instead, it refers to the distance between baselines when the font is set without any extra leading (`line-height` in CSS). It is quite possible for fonts to have characters that are taller than the default distance between baselines. For that matter, a font might be defined such that all of its characters are smaller than its em square, as many fonts do. Some hypothetical examples are shown in [Figure 13-12](#).

*A font with an em square smaller than some characters.*

*A font with an em square taller than all characters.*

*A font with an em square which is exactly large enough to contain all characters.*

**Figure 13-12. Font characters and em squares**

Thus, the effect of `font-size` is to provide a size for the em box of a given font. This does not guarantee that any of the actual displayed characters will be this size.

# Absolute Sizes

Having established all of that, we turn now to the absolute-size keywords. There are seven absolute-size values for `font-size: xx-small, x-small, small, medium, large, x-large, and xx-large`. These are not defined precisely, but are relative to each other, as [Figure 13-13](#) demonstrates:

```
p.one {font-size: xx-small;}  
p.two {font-size: x-small;}  
p.three {font-size: small;}  
p.four {font-size: medium;}  
p.five {font-size: large;}  
p.six {font-size: x-large;}  
p.seven {font-size: xx-large;}
```

According to the CSS1 specification, the difference (or *scaling factor*) between one absolute size and the next is about 1.5 going up the ladder, or 0.66 going down. Thus, if `medium` is the same as `10px`, then `large` should be the same as `15px`. This was later determined to be too large a scaling factor. In CSS2 it was suggested that it be somewhere between 1.0 and 1.2, and in CSS3 drafts a complicated series is provided (for example, `small` is listed as 8/9ths the size of `medium`, while `xx-small` is 3/5ths). In all case, the scaling factors are guidelines, as user agents are free to alter them for any reason.

This paragraph (class 'one') has a font size of 'xx-small'.

This paragraph (class 'two') has a font size of 'x-small'.

This paragraph (class 'three') has a font size of 'small'.

This paragraph (class 'four') has a font size of 'medium'.

This paragraph (class 'five') has a font size of 'large'.

This paragraph (class 'six') has a font size of 'x-large'.

This paragraph (class 'seven') has a font size of 'xx-large'.

**Figure 13-13. Absolute font sizes**

Working from the assumption that `medium` equals `16px`, for different scaling factors, we get the absolute size equivalents shown in [Table 13-5](#). (The values shown are rounded-off integers.)

Table 13-5. Scaling factors translated  
to pixels

**Keyword CSS1 CSS2 CSS3 (draft)**

`xx-small` 5px 9px 10px

`x-small` 7px 11px 12px

`small` 11px 13px 14px

`medium` 16px 16px 16px

`large` 24px 19px 19px

`x-large` 36px 23px 24px

`xx-large` 54px 28px 32px

# Relative Sizes

Comparatively speaking, the keywords `larger` and `smaller` are simple: they cause the size of an element to be shifted up or down the absolute-size scale, relative to their parent element, using the same scaling factor employed to calculate absolute sizes. In other words, if the browser used a scaling factor of 1.2 for absolute sizes, then it should use the same factor when applying relative-size keywords:

```
p {font-size: medium;}  
strong, em {font-size: larger;}  
  
<p>This paragraph element contains <strong>a strong-emphasis elem  
which itself contains <em>an emphasis element that also contains  
<strong>a strong element.</strong></em></strong></p>  
  
<p> medium <strong>large <em> x-large <strong>xx-large</strong> <
```

Unlike the relative values for weight, the relative-size values are not necessarily constrained to the limits of the absolute-size range. Thus, a font's size can be pushed beyond the sizes for `xx-small` and `xx-large`. For example:

```
h1 {font-size: xx-large;}  
em {font-size: larger;}  
  
<h1>A Heading with <em>Emphasis</em> added</h1>  
<p>This paragraph has some <em>emphasis</em> as well.</p>
```

As you can see in [Figure 13-14](#), the emphasized text in the `h1` element is slightly larger than `xx-large`. The amount of scaling is left up to the user agent, with the scaling factor of 1.2 being preferred but not required. The `em` text in the paragraph, of course, is shifted one slot up the absolute-size scale (`large`).

# A Heading with *Emphasis* added

This paragraph has some *emphasis* as well.

**xx-large (*larger*) xx-large**

**Figure 13-14.** Relative font sizing at the edges of the absolute sizes

**Note**

User agents are not required to increase or decrease font size beyond the limits of the absolute-size keywords.

# Percentages and Sizes

In a way, percentage values are very similar to the relative-size keywords. A percentage value is always computed in terms of whatever size is inherited from an element's parent. Percentages, unlike the size keywords previously discussed, permit much finer control over the computed font size. Consider the following example, illustrated in [Figure 13-15](#):

```
body {font-size: 15px;}  
p {font-size: 12px;}  
em {font-size: 120%;}  
strong {font-size: 135%;}  
small, .fnote {font-size: 70%;}  
  
<body>  
<p>This paragraph contains both <em>emphasis</em> and <strong>strong emphasis</strong>, both of which are larger than their parent element. The <small>small text</small>, on the other hand, is smaller by a quarter.  
<p class="fnote">This is a 'footnote' and is smaller than regular text.  
</body>
```

This paragraph contains both **emphasis** and **strong emphasis**, both of which are larger than their parent element. The small text, on the other hand, is smaller by a quarter.

This is a 'footnote' and is smaller than regular text.

12px 14.4px 12px 16.2px 12px 9px 12px

10.5px

**Figure 13-15. Throwing percentages into the mix**

In this example, the exact pixel size values are shown. These are the values calculated by the browser, regardless of the actual displayed size of the characters on-screen.

Incidentally, CSS defines the length value `em` to be equivalent to percentage values, in the sense that  $1\text{em}$  is the same as  $100\%$  when sizing fonts. Thus, the

following would yield identical results, assuming that both paragraphs have the same parent element:

```
p.one {font-size: 166%;}  
p.two {font-size: 1.6em;}
```

When using `em` measurements, the same principles apply as with percentages, such as the inheritance of computed sizes and so forth.

# Font Size and Inheritance

[Figure 13-12](#) also demonstrates that, although `font-size` is inherited in CSS, it is the computed values that are inherited, not percentages. Thus, the value inherited by the `strong` element is 12px, and this value is modified by the declared value 135% to arrive at 16.2px. For the “footnote” paragraph, the percentage is calculated in relation to the `font-size` value that’s inherited from the `body` element, which is 15px. Multiplying that value by 75% yields 11.25px.

As with the relative-size keywords, percentages are effectively cumulative. Thus, the following markup is displayed as shown in [Figure 13-16](#):

```
p {font-size: 12px;}  
em {font-size: 120%;}  
strong {font-size: 135%;}  
  
<p>This paragraph contains both<em>emphasis and <strong>strong  
emphasis</strong></em>, both of which are larger than the paragra  
  
<p> 12px <em>14.4px <strong> 19.44px </strong></em> 12px </p>  
  
This paragraph contains both emphasis and strong emphasis, both of which are larger than the paragraph text.  
12px 14.4px 19.44px 12px
```

**Figure 13-16. The issues of inheritance**

The size value for the `strong` element shown in [Figure 13-16](#) is computed as follows:

$$12 \text{ px} \times 120\% = 14.4\text{px}$$

$$14.4\text{px} \times 135\% = 19.44\text{px} \text{ (possibly rounded to 19px for display; see below)}$$

The problem of runaway scaling can go the other direction, too. Consider for a moment a document that is nothing but a series of unordered lists, many of them nested inside other lists. Some of these lists are four nested levels deep. Imagine the effect of the following rule on such a document:

```
ul {font-size: 80%;}
```

Assuming a four-level deep nesting, the most deeply nested unordered list would have a computed `font-size` value 40.96 percent the size of the parent of the top-level list. Every nested list would have a font size 80 percent as big as its parent list, causing each level to become harder and harder to read.

## Rounding for Display

In most modern browsers, while fractional `font-size` values are maintained internally, they are not always used by rendering engines. For example, study the letterforms in [Figure 13-17](#).

In all cases, the “O” characters increase by 0.1 pixels in size as you go from left to right. Thus, the leftmost “O” has a `font-size` of `10px`, the one at the midpoint has a size of `10.5px`, and the one on the right is `11px`.

As [Figure 13-17](#) reveals, different browser/OS combinations yield different results. For example, Opera, Safari, and Chrome for OS X show an abrupt jump from 10 pixels to 11 pixels at the `10.5px` position. Internet Explorer and Firefox for Windows (both 7 and 8) do the same. Firefox for OS X, on the other hand, looks like it has a smooth line of same-size text. In fact, the characters are all being drawn subtly differently, thanks to their subtly different font-size values. It’s hard to see without squinting (or a ruler), but the fact that it’s hard to tell there is an increase in size from one end of the line to the other is evidence enough.

OS X Opera	oooooooooooo
OS X Safari	oooooooooooo
OS X Chrome	oooooooooooo
OS X Firefox	oooooooooooo
Windows Firefox	oooooooooooo
Internet Explorer	oooooooooooo

**Figure 13-17. Fractional font sizes**

Nevertheless, every browser will yield up the same subpixel `font-size` values if you use an inspector or query the value directly via DOM scripting. The third “O” from the right will show a computed value of `10.8px`, regardless of the size of the character displayed on-screen.

## Keywords and Monospace Text

There’s an interesting wrinkle to font size keywords and inheritance that becomes apparent when you look at what some browsers do with monospace text (e.g., Courier). Consider the following, illustrated in [Figure 13-18](#):

```
p {font-size: medium;}      /* the default value */
span {font-family: monospace; font-size: 1em;}

<p>This is a 'p' with a <span>'span'</span> inside.</p>
```

This is a 'p' with a 'span' inside.

**Figure 13-18. Monospace size oddities**

The default value of `medium` is generally resolved to `16px`, assuming the user hasn’t changed the browser preferences (where the default text sizes are set).

Indeed, if you query the paragraph text outside the `span`, inspectors will tell you that the computed `font-size` of the text is `16px` (again, assuming the user hasn't changed the preferences).

So you might expect the monospaced `span` to also have 16 pixel text. That's exactly the case in some browsers, but in others, it will be `13px` instead.

The reason for this is that while the computed `font-size` of the paragraph is `16px`, the keyword `medium` is what's passed down through inheritance. Thus, the `span` starts out with `font-size: medium`. As a result, it looks to the user's preference settings to determine the proper size, and most browsers are set to a `13px` default size for all monospace text. This causes them to display 13-pixel monospace text in a 16-pixel parent, even though the monospace text was explicitly set to `font-size: 1em`.

The effect carries through even with font sizes other than `1em` (or `100%`); in the following case, the monospace text will have a computed size of `26px` instead of `32px` (once more assuming the browser defaults have not changed):

```
p {font-size: medium;} /* the default value */
span {font-family: monospace; font-size: 2em;}

<p>This is a 'p' with a <span>'span'</span> inside.</p>
```

Note that not all browsers actually do this: some override the `medium` sizing assumptions in favor of scaling off the computed `font-size` of the parent. This leads to inconsistent text display across browsers.

As it happens, there is a way to work around this problem that works for all known browsers, at least as of early 2013. It goes like this:

```
p {font-size: medium;} /* the default value */
span {font-family: monospace, serif; font-size: 1em;}

<p>This is a 'p' with a <span>'span'</span> inside.</p>
```

See the extra `serif` in the `font-family` there? That somehow triggers a switch that makes all browsers treat `font-size: 1em` as being 100% of the paragraph's computed `font-size`, not a `medium`-derived value. This is cross-browser-consistent and illustrated in [Figure 13-19](#).

This is a 'p' with a 'span' inside.

**Figure 13-19. Monospace size harmony**

# Using Length Units

The `font-size` can be set using any length value. All of the following `font-size` declarations should be equivalent:

```
p.one {font-size: 36pt;}  
p.two {font-size: 3pc;}  
p.three {font-size: 0.5in;}  
p.four {font-size: 1.27cm;}  
p.five {font-size: 12.7mm;}
```

The display in [Figure 13-20](#) assumes that the user agent knows how many dots per inch are used in the display medium. Different user agents make different assumptions—some based on the operating system, some based on preferences settings, and some based on the assumptions of the programmer who wrote the user agent. Nevertheless, the five lines should always have the same font size. Thus, while the result may not exactly match reality (for example, the actual size of `p.three` may not be half an inch), the measurements should all be consistent with one another.

**36 point font size**

**3 pica font size**

**0.5 inch font size**

**1.27 centimeter font size**

**12.7 millimeter font size**

**Figure 13-20.** Various font sizes

There is one more value that is potentially the same as those shown in [Figure 13-20](#), and that's 36px, which would be the same physical distance if the display medium is 72 pixels-per-inch (ppi). However, there are very few monitors with that setting anymore. Most desktop displays are much higher, in the range of 96ppi to 120ppi; and mobile devices go much higher, currently in the 300ppi – 500ppi range.

Despite these variations between operating systems and devices, many authors choose to use pixel values for font sizes. This approach seems especially attractive when mixing text and raster images (GIF, JPG, PNG, etc.) on a web page, since text can (in theory) be set to the same height as graphic elements on the page by declaring `font-size: 11px;` or something similar, as illustrated by [Figure 13-21](#).

**GREETINGS!** This text is set to a size of 11px so that it's close to the same size as the contents of the image-- which allows for a certain consistency in appearance. This approach is often used to make sure the body of a document is similar in size to the graphic buttons used in the design, even though this raises some accessibility and legibility issues.

**Figure 13-21. Keeping text and graphics in scale with pixel sizes**

Using pixel measurements for `font-size` is certainly one way to get “consistent” results with `font-size` (and, indeed, with any length at all), but there is a drawback. Not every browser makes it easy (or even possible) to resize text set in pixels, and there are situations where pixel-sized text can be badly sized in mobile devices that pretend to be full-screen devices (such as most versions of the iPhone). For these reasons alone, pixel-sizing text is generally not recommended.

# Automatically Adjusting Size

Two of the main factors that influence a font's legibility are its size and its x-height. The number that results from dividing the x-height by the `font-size` is referred to as the *aspect value*. Fonts with higher aspect values tend to be legible as the font's size is reduced; conversely, fonts with low aspect values become illegible more quickly. CSS provides a way to deal with shifts in aspect values between font families with the property `font-size-adjust`.

## **font-size-adjust**

### *Values*

`<number>` | `none` | `auto` | `inherit`

### *Initial value*

`none`

### *Applies to*

All elements

### *Inherited*

Yes

The goal of this property is to preserve legibility when the font used is not the author's first choice. Because of the differences in font appearance, while one font may be legible at a certain size, another font at the same size is difficult or impossible to read.

A good example is to compare the common fonts Verdana and Times. Consider [Figure 13-22](#) and the following markup, which shows both fonts at a `font-size` of 10px:

```

p {font-size: 10px;}
p.cl1 {font-family: Verdana, sans-serif;}
p.cl2 {font-family: Times, serif; }

Donec ut magna. Aliquam erat volutpat. Cum sociis natoque penatibus et magnis dis parturient montes, nascetur ridiculus mus. Nulla facilisi. Aenean mattis, dui et ullamcorper ornare, erat est sodales mi, non blandit sem ipsum quis justo. Nulla tincidunt.

Quisque et orci nec lacus hendrerit fringilla. Sed quam nibh, elementum et, scelerisque a, aliquam vestibulum, sapien. Etiam commodo auctor sapien. Pellentesque tincidunt lacus nec quam. Integer sit amet neque vel eros interdum ornare. Sed consequat.

```

**Figure 13-22. Comparing Verdana and Times**

The text in Times is much harder to read than the Verdana text. This is partly due to the limitations of pixel-based display, but it is also because Times simply becomes harder to read at smaller font sizes.

As it turns out, the ratio of x-height to character size in Verdana is 0.58, whereas in Times it is 0.46. What you can do in this case is declare the aspect value of Verdana, and the user agent will adjust the size of the text that's actually used. This is accomplished using the formula:

Declared `font-size` × (`font-size-adjust` value ÷ aspect value of available font) = Adjusted `font-size`

So, in a situation where Times is used instead of Verdana, the adjustment is as follows:

$$10\text{px} \times (0.58 \div 0.46) = 12.6\text{px}$$

which leads to the result shown in [Figure 13-23](#):

```

p {font: 10px Verdana, sans-serif; font-size-adjust: 0.58;}
p.cl2 {font-family: Times, serif; }

Donec ut magna. Aliquam erat volutpat. Cum sociis natoque penatibus et magnis dis parturient montes, nascetur ridiculus mus. Nulla facilisi. Aenean mattis, dui et ullamcorper ornare, erat est sodales mi, non blandit sem ipsum quis justo. Nulla tincidunt.

Quisque et orci nec lacus hendrerit fringilla. Sed quam nibh, elementum et, scelerisque a, aliquam vestibulum, sapien. Etiam commodo auctor sapien. Pellentesque tincidunt lacus nec quam. Integer sit amet neque vel eros interdum ornare. Sed consequat.

```

**Figure 13-23. Adjusting Times**

Of course, to allow a user agent to intelligently make size adjustments, it first has to know the aspect value of the fonts you specify. User agents that support `@font-face` will be able to pull that information directly from the font file, assuming the files contain the information—any professionally-produced font should, but there's no guarantee. If a font file doesn't contain the aspect value, a user agent may try to compute it, but again, there's no guarantee that they will or even can.

Assuming that the user agent can find or figure out aspect values, the `auto` value for `font-size-adjust` is a way of getting the desired effect even if you don't know the actual aspect value of your first-choice font. For example, given that the user agent can determine that the aspect value of Verdana is 0.58, then the following will have the same result as that shown in [Figure 13-23](#):

```
p {font: 10px Verdana, sans-serif; font-size-adjust: auto;}  
p.cl2 {font-family: Times, serif; }
```

Declaring `font-size-adjust: none;` will, obviously, suppress any adjustment of font sizes. This is the default state.

**Note**

As of early 2013, the only user agent line to support `font-size-adjust` was the Gecko family.

# Font Style

`font-style` is very simple: it's used to select between `normal` text, `italic` text, and `oblique` text. That's it! The only complication is in recognizing the difference between `italic` and `oblique` text and in understanding why browsers don't always give you a choice.

## **font-style**

### *Values*

`italic` | `oblique` | `normal` | `inherit`

### *Initial value*

`normal`

### *Applies to*

All elements

### *Inherited*

Yes

### *Computed value*

As specified

### *Note*

Has a corresponding `@font-face` descriptor (see below)

The default value of `font-style` is, as you can see, `normal`. This refers to “upright” text, which is probably best described as “text that is not italic or otherwise slanted.” The vast majority of text in this book is upright, for

instance. That leaves only an explanation of the difference between `italic` and `oblique` text. For that, it's easiest to refer to [Figure 13-24](#), which illustrates the differences very clearly.

Basically, italic text is a separate font face, with small changes made to the structure of each letter to account for the altered appearance. This is especially true of serif fonts, where, in addition to the fact that the text characters “lean,” the serifs may be altered in an italic face. Oblique text, on the other hand, is simply a slanted version of the normal, upright text. Font faces with labels like “Italic,” “Cursive,” and “Kursiv” are usually mapped to the `italic` keyword, while `oblique` is often assigned faces with labels such as “Oblique,” “Slanted,” and “Incline.”

*italic text sample*

**oblique text sample**

**Figure 13-24. Italic and oblique text in detail**

If you want to make sure that a document uses italic text in familiar ways, you could write a style sheet like this:

```
p {font-style: normal;}  
em, i {font-style: italic;}
```

These styles would make paragraphs use an upright font, as usual, and cause the `em` and `i` elements to use an italic font—again, as usual. On the other hand, you might decide that there should be a subtle difference between `em` and `i`:

```
p {font-style: normal;}  
em {font-style: oblique;}  
i {font-style: italic;}
```

If you look closely at [Figure 13-25](#), you'll see there is no apparent difference between the `em` and `i` elements. In practice, not every font is so sophisticated

as to have both an italic face and an oblique face, and even fewer web browsers are sophisticated enough to tell the difference when both faces do exist.

This paragraph has a 'font-style' of 'normal', which is why it looks... normal. The exception are those elements which have been given a different style, such as the '*EM*' element and the '*T*' element, which get to be oblique and italic, respectively.

**Figure 13-25. More font styles**

If either of these is the case, then there are a few things that can happen. If there is no “Italic” face available, but there is an “Oblique” face, then the latter can be used for the former. If the situation is reversed—an “Italic” face exists, but there is no defined “Oblique” face—the user agent may *not* substitute the former for the latter, according to the specification. Finally, the user agent can simply generate the oblique face by computing a slanted version of the upright font. In fact, this is what most often happens in a digital world, where it’s fairly simple to slant a font using a simple computation.

Furthermore, you may find that in some operating systems, a given font that has been declared as `italic` may switch from italic to oblique depending on the actual size of the font. The display of Times on a Macintosh running the Classic OS (Mac OS 9), for example, is shown in [Figure 13-26](#), where the only difference is a single pixel in font size.

This paragraph contains a *stretch of italicized text* within.

This paragraph contains a *stretch of italicized text* within.

**Figure 13-26. Same font, same style, different sizes**

There isn’t much that can be done about this, unfortunately, except better font handling. Fortunately, modern operating systems such as Mac OS X and Windows XP have very good font rendering technology, and `@font-face` allows authors to assign specific italic and oblique faces to the respective `font-style` properties, should they so choose.

Even though italic and oblique text often use the same face, `font-style` can

still be quite useful. For example, it is a common typographic convention that a block quote should be italicized, but that any specially emphasized text within the quote should be upright. To employ this effect, which is illustrated in [Figure 13-27](#), you would use these styles:

```
blockquote {font-style: italic;}  
blockquote em, blockquote i {font-style: normal;}
```

Once upon a time, on a 'net not so far away, someone was heard to say:

*Of course, workarounds, compatibility charts, and "bug list" pages are just a symptom of the problem, not the solution. Suffice it to say that, in light of all our problems, the only real solution is this: browsers must become conformant with the CSS specifications. Otherwise, we'll be stuck with a Web so fragmented it will hurt. A lot.*

**Figure 13-27. Common typographical conventions through CSS**

A related property tells the user agent whether it's allowed to synthesize its own bold or italic faces when a family doesn't contain them.

# The font-style Descriptor

As a descriptor, `font-style` lets an author link specific faces to specific font-style values.

```
@font-face {  
    font-family: "SwitzeraADF";  
    font-style: normal;  
    src: url("SwitzeraADF-Regular.otf") format("opentype");  
}  
  
@font-face {  
    font-family: "SwitzeraADF";  
    font-style: italic;  
    src: url("SwitzeraADF-Italic.otf") format("opentype");  
}  
@font-face {  
    font-family: "SwitzeraADF";  
    font-style: oblique;  
    src: url("SwitzeraADF-Italic.otf") format("opentype");  
}
```

Given the above, the result of the following rules would be to render `h2` and `h3` elements using “SwitzeraADF-Italic” instead of “SwitzeraADF-Regular,” as illustrated in [Figure 13-28](#):

```
h1, h2, h3 {font: 225% SwitzeraADF, Helvetica, sans-serif;}  
h2 {font-size: 180%; font-style: italic;}  
h3 {font-size: 150%; font-style: oblique;}
```

A Level 1 Heading Element

*A Level 2 Heading Element*

*A Level 3 Heading Element*

**Figure 13-28.** Using declared font-style faces

Of course, if there were a SwitzeraADF face with an oblique typeface, the author could point to it instead of the italic variant. There isn't such a face, though, so the author mapped the italic face to both the `italic` and `oblique` values. As with `font-weight`, the `font-style` descriptor can take all of the values of the `font-style` property *except* for `inherit`.

# Font Stretching

In some font families, there are a number of variant faces that have wider or narrower letterforms. These often take names like “Condensed,” “Wide,” “Ultra Expanded,” and so on. The utility of such variants is that a designer can use a single font family while also having skinny and fat variants. CSS provides a property that allows an author to select among such variants, when they exist, without having to explicitly define them in `font-family` declarations. It does this via the somewhat misleadingly named `font-stretch`.

## **font-stretch**

### *Values*

`normal` | `ultra-condensed` | `extra-condensed` | `condensed` | `semi-condensed` | `semi-expanded` | `expanded` | `extra-expanded` | `ultra-expanded` | `inherit`

### *Initial value*

`normal`

### *Applies to*

All elements

### *Inherited*

Yes

### *Note*

Has a corresponding `@font-face` descriptor (see below)

You might expect from the property name that this will stretch or squeeze a

font like saltwater taffy, but that's actually not the case at all. As the value names imply, this property instead behaves very much like the absolute-size keywords (e.g., `xx-large`) for the `font-size` property, with a range of absolute values that (in theory) let the author alter a font's width. For example, an author might decide to stress the text in a strongly emphasized element by changing the font characters to a wider face than their parent element's font characters.

The catch is that this property only works if the font family in use has defined wider and narrower faces, which most do not (and those that do are usually very expensive). Thus this property is actually very different from `font-size`, which can change the size of any font face at any time. In contrast, declaring `font-stretch: expanded` will only have an effect if the font in use has an expanded face available. If it doesn't, then nothing will happen: the font's face will not change.

For example, consider the very common font Verdana, which has only one width face; this is equivalent to `font-stretch: normal`. Declaring the following will have no effect on the width of the displayed text:

```
body {font-family: Verdana;}  
strong {font-stretch: extra-expanded;}  
footer {font-stretch: extra-condensed;}
```

All of the text will be at Verdana's usual width. However, if the font family is changed to one that has a number of width faces, such as Futura, then things will be different, as shown in [Figure 13-29](#):

```
body {font-family: Verdana;}  
strong {font-stretch: extra-expanded;}  
footer {font-stretch: extra-condensed;}
```

If there one thing I can't **stress enough**, it's the value of Photoshop in producing books like this one.

Especially in footers.

**Figure 13-29. Stretching font characters**

**Note**

As of early 2013, only Gecko-based browsers and Internet Explorer 9+ supported `font-stretch`. Furthermore, as noted, they only supported it for font families that have variant faces available.

# The font-stretch Descriptor

Much as with the `font-weight` descriptor, the `font-stretch` descriptor allows authors to explicitly assign faces of varying widths to the width values permitted in the `font-stretch` property. For example, the following rules explicitly assign three faces to the most directly analogous `font-stretch` values:

```
@font-face {  
    font-family: "SwitzeraADF";  
    font-stretch: normal;  
    src: url("SwitzeraADF-Regular.otf") format("opentype");  
}  
@font-face {  
    font-family: "SwitzeraADF";  
    font-stretch: condensed;  
    src: url("SwitzeraADF-Cond.otf") format("opentype");  
}  
@font-face {  
    font-family: "SwitzeraADF";  
    font-stretch: expanded;  
    src: url("SwitzeraADF-Ext.otf") format("opentype");  
}
```

In a parallel to what we saw in previous sections, the author can call on these different width faces through the `font-stretch` property, as illustrated in [Figure 13-30](#):

```
h1, h2, h3 {font: 225% SwitzeraADF, Helvetica, sans-serif;}  
h2 {font-size: 180%; font-stretch: condensed;}  
h3 {font-size: 150%; font-stretch: expanded;}
```

As before, the `font-stretch` descriptor can take all of the values of the `font-stretch` property *except* for `inherit`.

# A Level 1 Heading Element

## A Level 2 Heading Element

### A Level 3 Heading Element

Figure 13-30. Using declared font-stretch faces

# Font Kerning

Some fonts contain data regarding how characters should be spaced relative to each other, known as *kerning*. This spacing can vary depending on how characters are combined; for example, the character pair “oc” may have a different spacing than the pair “ox.” Similarly, “AB” and “AW” may have different separation distances, to the point that in some fonts, the top-right tip of the “W” is actually placed to the left of the bottom-right tip of the “A.” This kerning data can be explicitly called for or suppressed using the property `font-kerning`.

## **font-kerning**

### *Values*

`auto` | `normal` | `none` | `inherit`

### *Initial value*

`auto`

### *Applies to*

All elements

### *Inherited*

Yes

The value `none` is pretty obvious: it tells the user agent to ignore any kerning information in the font. `normal` tells the user agent to kern the text normally; that is, according to the kerning data contained in the font. `auto` tells the user agent to do whatever it thinks best, possibly depending on the type of font in use. The OpenType specification, for example, recommends (but does not require) that kerning be applied whenever the font supports it. If a font does not contain kerning data, of course, `font-kerning` will have no effect.

**Note**

Note that if the property `letter-spacing` is applied to kerned text, the kerning is done and *then* the letters' spacing is adjusted according to the value of `letter-spacing`, not the other way around.

# Font Variants

Beyond font weights, font styles, and so forth, there are font variants. These are embedded within a font face and can cover things like various styles of historical ligatures, small-caps presentation, ways of presenting fractions, the spacing of numbers, whether zeroes get slashes through them, and much more. CSS lets authors invoke these variants, when they exist, through `font-variant`.

## **font-variant**

### *Values (CSS2.1)*

`normal` | `small-caps`

### *Values (Level 3)*

`normal` | `none` | [ `<common-lig-values>` || `<discretionary-lig-values>` || `<historical-lig-values>` || `<contextual-alt-values>` || `stylistic(<feature-value-name>)` || `historical-forms` || `styleset(<feature-value-name>)` || `character-variant(<feature-value-name>)` || `swash(<feature-value-name>)` || `ornaments(<feature-value-name>)` || `annotation(<feature-value-name>)` || [ `small-caps` | `all-small-caps` | `petite-caps` | `all-petite-caps` | `unicase` | `titling-caps` ] || `<numeric-figure-values>` || `<numeric-spacing-values>` || `<numeric-fraction-values>` || `ordinal` || `slashed-zero` || `<east-asian-variant-values>` || `<east-asian-width-values>` || `ruby` ] ] | `inherit`

### *Initial value*

`normal`

### *Applies to*

All elements

*Inherited*

Yes

*Computed value*

As specified

*Note*

Has a corresponding `@font-face` descriptor (see below)

That's quite a "Values (Level 3)" entry, isn't it? Especially when the only values in CSS1 and CSS2 were the default of `normal`, which describes ordinary text, and `small-caps`, which calls for the use of small-caps text. Let's concentrate just on those for a moment.

Instead of upper- and lowercase letters, a small-caps font employs uppercase letters of different sizes. Thus, you might see something like that shown in [Figure 13-31](#):

```
h1 {font-variant: small-caps;}  
h1 code, p {font-variant: normal;}  
  
<h1>The Uses of <code>font-variant</code> On the Web</h1>  
<p>  
The property <code>font-variant</code> is very interesting...  
</p>
```

## THE USES OF `font-variant`

The property `font-variant` is very interesting. Given how common its use is in print media and the relative ease of its implementation, it should be supported by every CSS1-aware browser.

**Figure 13-31.** The `small-caps` value in use

As you may notice, in the display of the `h1` element, there is a larger

uppercase letter wherever an uppercase letter appears in the source and a small uppercase letter wherever there is a lowercase letter in the source. This is very similar to `text-transform: uppercase`, with the only real difference being that, here, the uppercase letters are of different sizes. However, the reason that `small-caps` is declared using a font property is that some fonts have a specific small-caps face, which a font property is used to select.

What happens if no such face exists? There are two options provided in the specification. The first is for the user agent to create a small-caps face by scaling uppercase letters on its own. The second is simply to make all letters uppercase and the same size, exactly as if the declaration `text-transform: uppercase;` had been used instead. This is obviously not an ideal solution, but it is permitted.

# Level 3 Values

Now to examine that “Values (Level 3)” line. It is admittedly complicated, but there’s an easy way to explain it. It’s actually a shorthand for all the values permitted for the following properties:

- `font-variant-ligatures`
- `font-variant-caps`
- `font-variant-numeric`
- `font-variant-alternates`
- `font-variant-east-asian`

As an example (to pick one of the simpler ones), `<common-lig-values>` comes from the property `font-variant-ligatures`, and can be either `common-ligatures` or `no-common-ligatures`. `<numeric-fraction-values>` comes from `font-variant-numeric` and can be either `diagonal-fractions` or `stacked-fractions`. And so on.

There are two barriers to the use of these admittedly much more powerful font variants: browser support and font support. The first is easy: as of mid-2013, there isn’t widespread support for enabling font variants. Certainly you can use the CSS 2.1 variant values, but many of the Level 3 values are only supported by Gecko.

The second is also easy while also being complex: not every font supports every variant. For example, most Latin fonts won’t support any of the East Asian variants; for another, not every font will include support for, say, some of the numeric and ligature variants. To find out what a given font supports, you have to consult its documentation, or do a lot of testing no documentation is available. (Most commercial fonts do come with documentation, and most free fonts don’t.)

The main thing to keep in mind is that even if a variant works in a given browser for one font, it may not for another; and just because a font has a given variant, that doesn't mean that all browsers will let you invoke it. So it's complicated, and there aren't many detailed guides to help out.

#### Note

The various `font-variant-*` properties are not covered in detail here because as of early 2013, they were not well supported in browsers. For more details, see

<http://w3.org/TR/css3-fonts/>.

## The font-variant Descriptor

The `font-variant` descriptor lets you decide which of a font face's variants can or cannot be used, specified as a space-separated list. For example, you can enable the common ligature, small caps, and slashed-zeroes variants like so:

```
font-variant: common-ligatures small-caps slashed-zero;
```

You'll no doubt have guessed by now that the `font-variant` descriptor can take all of the values of the `font-variant` property *except* for `inherit`.

Note that this descriptor is very different than the other descriptors we've seen so far. With the `font-stretch` descriptor, for example, you can assign a specific font face to a given `font-stretch` property value. The `font-variant` descriptor, by contrast, defines which variants are permitted for the font face being declared in the `@font-face` rule, which can easily negate font variant values called for in properties later on. For example, given the following, paragraphs will *not* be displayed using a `diagonal-fractions` or `small-caps` variant, even if such variants exist in SwitzeraADF:

```
@font-face {  
    font-family: "SwitzeraADF";  
    font-weight: normal;  
    src: url("SwitzeraADF-Regular.otf") format("opentype");  
}
```

```
    font-variant: stacked-fractions titling-caps slashed-zero;
}

p {font: small-caps 1em SwitzeraADF, sans-serif; font-variant-num
```

# Font Features

In a manner similar to `font-variant`, the `font-feature-settings` descriptor allows authors to exercise low-level control over which OpenType font features are available for use (so don't go using this descriptor on `.woff` files).

## **font-feature-settings**

### *Values*

`normal` | `<feature-tag-value>#` | `inherit`

### *Initial value*

`normal`

### *Note*

Has a corresponding `@font-face` descriptor (see below)

You can list one or more comma-separated OpenType features, as defined by the OpenType specification. For example, enabling common ligatures, small caps, and slashed zeroes would look something like this:

```
font-feature-settings: "liga" on, "smcp" on, "zero" on;
```

The exact format of a `<feature-tag-value>` value is:

`<feature-tag-value>`

`<string> [ <integer> | on | off ]?`

For many features, the only permitted integer values are `0` and `1`, which are equivalent to `off` and `on` (and vice versa). There are some features that allow a range of numbers, however, in which case values greater than `1` both enable

the feature and define the feature's selection index. If a feature is listed but no number is provided, 1 (on) is assumed. Thus, the following descriptors are all equivalent:

```
font-feature-settings: "liga";      /* 1 is assumed */
font-feature-settings: "liga" 1;    /* 1 is declared */
font-feature-settings: "liga" on;   /* on = 1 */
```

Remember that all *<string>* values *must* be quoted. Thus, the first of the following descriptors will be recognized, but the second will be ignored:

```
font-feature-settings: "liga", dlig;
/* common ligatures are enabled; we wanted discretionary ligature
```

A further restriction is that OpenType requires that all feature tags be four ASCII characters long. Any feature name longer or shorter, or that uses non-ASCII characters, is invalid and will be ignored. (This isn't something you personally need to worry about unless you're using a font that has its own made-up feature names and the font's creator didn't follow the naming rules.)

By default, OpenType fonts *always* have the following features enabled unless the author explicitly disables them via `font-feature-settings` or `font-variant`:

calt

Contextual alternates

ccmp

Composed characters

clig

Contextual ligatures

liga

Standard ligatures

locl

## Localized forms

mark

Mark to base positioning

mkmk

Mark to mark positioning

rlig

Required ligatures

Additionally, other features may be enabled by default in specific situations, such as `vert` (Vertical alternates) for vertical runs of text.

### Note

A complete list of standard OpenType feature names can be found at

<http://microsoft.com/typography/otspec/featurelist.htm>.

# The font-feature-settings Descriptor

The `font-feature-settings` descriptor lets you decide which of an OpenType font face's settings can or cannot be used, specified as a space-separated list.

Now, hold up a second—isn't that almost exactly what we did with `font-variant` just a few paragraphs ago? As a matter of fact, yes, it is. The `font-variant` descriptor covers nearly everything `font-feature-settings` does, plus a little more besides. It simply does so in a more CSS-like way, with value names instead of cryptic OpenType identifiers and Boolean toggles. Because of this, the CSS specification explicitly encourages authors to use `font-variant` instead of `font-feature-settings`, except in those cases where there's a font feature that the value list of `font-variant` doesn't include.

Keep in mind that this descriptor merely makes features available for use (or suppresses their use). It does not actually turn them on for the display of text; for that, see the section on the `font-feature-settings` property, described above.

Just as with the `font-variant` descriptor, the `font-feature-settings` descriptor defines which font features are permitted for the font face being declared in the `@font-face` rule. This can easily negate font feature values called for in properties later on. For example, given the following, paragraphs will *not* be displayed using alternative fractions nor small-caps, even if such features exist in SwitzeraADF:

```
@font-face {  
    font-family: "SwitzeraADF";  
    font-weight: normal;  
    src: url("SwitzeraADF-Regular.otf") format("opentype");  
    font-feature-settings: "afrc" off, "smcp" off;  
}  
  
p {font: 1em SwitzeraADF, sans-serif; font-feature-settings: "afr
```

As always, the `font-feature-settings` descriptor can take all of the values of the `font-feature-settings` property *except* for `inherit`.

# Font Synthesis

It is sometimes the case that a given font family will lack alternate faces for things like bold or italic text. In such situations, the user agent may attempt to synthesize a face from the faces it has available, but this can lead to unattractive letterforms. To address this, CSS offers `font-synthesis`, which lets authors say how much synthesis they will or won't permit in the rendering of a page.

## `font-synthesis`

### *Values*

`none` | `[weight || style]` | `inherit`

### *Initial value*

`weight` `style`

### *Applies to*

All elements

### *Inherited*

Yes

In many user agents, a font family that has no bold face can have one computed for it. This might be done by adding pixels to either side of each character glyph, for example. While this might seem useful, it can lead to results that are visually unappealing. This is why most font families actually have bold faces included: the font's designer wanted to make sure that bolded text in that font looked good.

Similarly, a font family that lacks an italic face can have one synthesized by simply slanting the characters in the normal face. This tends to look even

worse than synthesized bold faces, particularly when it comes to serif fonts. Compare the difference between a synthesized italic version of Georgia (which we’re calling “oblique” here) and the actual italic face included in Georgia, illustrated in [Figure 13-32](#).

In supporting user agents, declaring `font-synthesis: none` blocks the user agent from doing any such synthesis for the affected elements. You can block it for the whole document with `html {font-synthesis: none;}`, for example. The downside is that any attempts to bold or italicize text using a font that doesn’t offer the appropriate faces will stay unbolted or unitalicized. The upside is that you don’t have to worry about a user agent trying to synthesize those variants and doing a poor job of it.

**Note**

As of early 2013, there was no known user agent support for `font-synthesis`. It is included here mostly as a future-looking reference.

*italic text sample*

*oblique text sample*

**Figure 13-32.** Synthesized versus designed italics

# The font Property

All of these properties are very sophisticated, of course, but using them all could get a little tedious:

```
h1 {font-family: Verdana, Helvetica, Arial, sans-serif; font-size:  
    font-weight: 900; font-style: italic; font-variant: small-caps  
h2 {font-family: Verdana, Helvetica, Arial, sans-serif; font-size:  
    font-weight: bold; font-style: italic; font-variant: normal;}
```

Some of this problem could be solved by grouping selectors, but wouldn't it be easier to combine everything into a single property? Enter `font`, which is the shorthand property for all the other font properties (and a little more besides).

## **font**

### *Values*

`[[ <font-style> || [ normal | small-caps ] || <font-weight> ]? <font-size> [ / <line-height> ]? <font-family>] | caption | icon | menu | message-box | small-caption | status-bar | inherit`

### *Initial value*

Refer to individual properties

### *Applies to*

All elements

### *Inherited*

Yes

### *Percentages*

Calculated with respect to the parent element for `<font-size>` and with respect to the element's `<font-size>` for `<line-height>`

*Computed value*

See individual properties (`font-style`, etc.)

Generally speaking, a `font` declaration can have any one value from each of the listed font properties, or else a “system font” value (described in [“Using System Fonts”](#)). Therefore, the preceding example could be shortened as follows (and have exactly the same effect, as illustrated by [Figure 13-33](#)):

```
h1 {font: italic 900 small-caps 30px Verdana, Helvetica, Arial, sans-serif;
h2 {font: bold normal italic 24px Verdana, Helvetica, Arial, sans-serif;
```

## **A LEVEL 1 HEADING ELEMENT**

### **A Level 2 Heading Element**

**Figure 13-33.** Typical font rules

I say that the styles “could be” shortened in this way because there are a few other possibilities, thanks to the relatively loose way in which `font` can be written. If you look closely at the preceding example, you’ll see that the first three values don’t occur in the same order. In the `h1` rule, the first three values are the values for `font-style`, `font-weight`, and `font-variant`, in that order. In the second, they’re ordered `font-weight`, `font-variant`, and `font-style`. There is nothing wrong here because these three can be written in any order. Furthermore, if any of them has a value of `normal`, that can be left out altogether. Therefore, the following rules are equivalent to the previous example:

```
h1 {font: italic 900 small-caps 30px Verdana, Helvetica, Arial, sans-serif;
h2 {font: bold italic 24px Verdana, Helvetica, Arial, sans-serif;
```

In this example, the value of `normal` was left out of the `h2` rule, but the effect is exactly the same as in the preceding example.

It's important to realize, however, that this free-for-all situation applies only to the first three values of `font`. The last two are much stricter in their behavior. Not only must `font-size` and `font-family` appear in that order as the last two values in the declaration, but both must always be present in a `font` declaration. Period, end of story. If either is left out, then the entire rule will be invalidated and very likely to be ignored completely by a user agent. Thus, the following rules will get you the result shown in [Figure 13-34](#):

```
h1 {font: normal normal italic 30px sans-serif;} /*no problem h  
h2 {font: 1.5em sans-serif;} /* also fine; omitted values set t  
h3 {font: sans-serif;} /* INVALID--no 'font-size' provided */  
h4 {font: lighter 14px;} /* INVALID--no 'font-family' provided
```

# A Level 1 Heading Element

## A Level 2 Heading Element

### A Level 3 Heading Element

#### A Level 4 Heading Element

**Figure 13-34.** The necessity of both size and family

# Adding the Line Height

So far, we've treated `font` as though it has only five values, which isn't quite true. It is also possible to set the value of the property `line-height` using `font`, despite the fact that `line-height` is a text property (not covered in this text), not a font property. It's done as a sort of addition to the `font-size` value, separated from it by a forward slash (/):

```
body {font-size: 12px;}  
h2 {font: bold italic 200%/1.2 Verdana, Helvetica, Arial, sans-se
```

These rules, demonstrated in [Figure 13-35](#), set all `h2` elements to be bold and italic (using `face` for one of the sans-serif font families), set the `font-size` to `24px` (twice the `body`'s size), and set the `line-height` to `28.8px`.

## ***A level 2 heading element which has had a 'line-height' of '36pt' set for it***

**Figure 13-35.** Adding line height to the mix

This addition of a value for `line-height` is entirely optional, just as the first three `font` values are. If you do include a `line-height`, remember that the `font-size` always comes before `line-height`, never after, and the two are always separated by a slash.

This may seem repetitive, but it's one of the most common errors made by CSS authors, so I can't say it enough: the required values for `font` are `font-size` and `font-family`, in that order. Everything else is strictly optional.

### Note

`line-height` is discussed in detail in my upcoming book, *CSS Text Styling*.

# Using Shorthands Properly

It is important to remember that `font`, being a shorthand property, can act in unexpected ways if you are careless with its use. Consider the following rules, which are illustrated in [Figure 13-36](#):

```
h1, h2, h3 {font: italic small-caps 250% sans-serif;}  
h2 {font: 200% sans-serif;}  
h3 {font-size: 150%;}  
  
<h1>This is an h1 element</h1>  
<h2>This is an h2 element</h2>  
<h3>This is an h3 element</h3>
```

*A LEVEL 1 HEADING ELEMENT*

*A Level 2 Heading Element*

*A LEVEL 3 HEADING ELEMENT*

**Figure 13-36.** Shorthand changes

Did you notice that the `h2` element is neither italicized nor small-capped, and that none of the elements are bold? This is the correct behavior. When the shorthand property `font` is used, any omitted values are reset to their defaults. Thus, the previous example could be written as follows and still be exactly equivalent:

```
h1, h2, h3 {font: italic normal small-caps 250% sans-serif;}  
h2 {font: normal normal normal 200% sans-serif;}  
h3 {font-size: 150%;}
```

This sets the `h2` element's font style and variant to `normal`, and the `font-weight` of all three elements to `normal`. This is the expected behavior of shorthand properties. The `h3` does not suffer the same fate as the `h2` because

you used the property `font-size`, which is not a shorthand property and therefore affects only its own value.

# Using System Fonts

In situations where you want to make a web page “blend in” with the user’s operating system, the system font values of `font` come in very handy. These are used to take the font size, family, weight, style, and variant of elements of the operating system, and apply them to an element. The values are as follows:

`caption`

Used for captioned controls, such as buttons

`icon`

Used to label icons

`menu`

Used in menus—that is, drop-down menus and menu lists

`message-box`

Used in dialog boxes

`small-caption`

Used for labeling small controls

`status-bar`

Used in window status bars

For example, you might want to set the font of a button to be the same as that of the buttons found in the operating system. For example:

```
button {font: caption;}
```

With these values, it is possible to create web-based applications that look

very much like applications native to the user's operating system.

Note that system fonts may only be set as a whole; that is, the font family, size, weight, style, etc., are all set together. Therefore, the button text from our previous example will look exactly the same as button text in the operating system, whether or not the size matches any of the content around the button. You can, however, alter the individual values once the system font has been set. Thus, the following rule will make sure the button's font is the same size as its parent element's font:

```
button {font: caption; font-size: 1em;}
```

If you call for a system font and no such font exists on the user's machine, the user agent may try to find an approximation, such as reducing the size of the `caption` font to arrive at the `small-caption` font. If no such approximation is possible, then the user agent should use a default font of its own. If it can find a system font but can't read all of its values, then it should use the default value. For example, a user agent may be able to find a `status-bar` font but not get any information about whether the font is `small-caps`. In that case, the user agent will use the value `normal` for the `small-caps` property.

# Font Matching

As we've seen, CSS allows for the matching of font families, weights, and variants. This is all accomplished through font matching, which is a vaguely complicated procedure. Understanding it is important for authors who want to help user agents make good font selections when displaying their documents. I left it for the end of the chapter because it's not really necessary to understand how the font properties work, and some readers will probably want to skip this part. If you're still interested, here's how font matching works:

1. The user agent creates, or otherwise accesses, a database of font properties. This database lists the various CSS properties of all of the fonts to which the user agent has access. Typically, this will be all fonts installed on the machine, although there could be others (for example, the user agent could have its own built-in fonts). If the user agent encounters two identical fonts, it will simply ignore one of them.
2. The user agent takes apart an element to which font properties have been applied and constructs a list of font properties necessary for the display of that element. Based on that list, the user agent makes an initial choice of a font family to use in displaying the element. If there is a complete match, then the user agent can use that font. Otherwise, it needs to do a little more work.
3. A font is first matched against the `font-stretch` property.
4. A font is next matched against the `font-style` property. The keyword `italic` is matched by any font that is labeled as either “italic” or “oblique.” If neither is available, then the match fails.
5. The next match is to `font-weight`, which can never fail thanks to the way `font-weight` is handled in CSS (explained earlier in the chapter).
6. Then, `font-size` is tackled. This must be matched within a certain

tolerance, but that tolerance is defined by the user agent. Thus, one user agent might allow matching within a 20 percent margin of error, whereas another might allow only 10 percent differences between the size specified and the size that is actually used.

7. If there was no font match in Step 2, the user agent looks for alternate fonts within the same font family. If it finds any, then it repeats Step 2 for that font.
8. Assuming a generic match has been found, but it doesn't contain everything needed to display a given element—the font is missing the copyright symbol, for instance—then the user agent goes back to Step 3, which entails a search for another alternate font and another trip through Step 2.
9. Finally, if no match has been made and all alternate fonts have been tried, then the user agent selects the default font for the given generic font family and does the best it can to display the element correctly.

Furthermore, the user agent does the following to resolve handling of font variants and features:

1. First, check for font features enabled by default, including features required for a given script. The core set of default-enabled features is: "calt", "ccmp", "clig", "liga", "locl", "mark", "mkmk", "rlig".
2. Then, if the font is defined via an `@font-face` rule, check for the features implied by the `font-variant` descriptor in the `@font-face` rule. Then check for the font features implied by the `font-feature-settings` descriptor in the `@font-face` rule.
3. Then check feature settings determined by properties other than `font-variant` or `font-feature-settings`. (For example, setting a non-default value for the `letter-spacing` property will disable ligatures.)
4. Then check for features implied by the value of the `font-variant` property, the related `font-variant` subproperties (e.g., `font-variant-`

ligatures), and any other property that may call for the use of OpenType features (e.g., `font-kerning`).

5. Finally, check for the features implied by the value of `font-feature-settings` property.

The whole process is long and tedious, but it helps to understand how user agents pick the fonts they do. For example, you might specify the use of Times or any other serif font in a document:

```
body {font-family: Times, serif;}
```

For each element, the user agent should examine the characters in that element and determine whether Times can provide characters to match. In most cases, it can do so with no problem. Assume, however, that a Chinese character has been placed in the middle of a paragraph. Times has nothing that can match this character, so the user agent has to work around the character or look for another font that can fulfill the needs of displaying that element. Of course, any Western font is highly unlikely to contain Chinese characters, but should one exist (let's call it AsiaTimes), the user agent could use it in the display of that one element—or simply for the single character. Thus, the whole paragraph might be displayed using AsiaTimes, or everything in the paragraph might be in Times except for the single Chinese character, which is displayed in AsiaTimes.

# Summary

From what was initially a very simplistic set of font properties, CSS has rapidly grown to allow fine-grained and wide-ranging influence over how fonts are displayed on the web. From custom fonts downloaded over the web to custom-built families assembled out of a variety of individual faces, authors may be fairly said to overflow with font power.

The typographic options available to authors today are far stronger than ever, but always remember: you must use this power wisely. While you can have seventeen different fonts in use on your site, that definitely doesn't mean that you should. Quite aside from the aesthetic difficulties this could present for your users, it would also make the total page weight much, much higher than it needs to be. As with any other aspect of web design, authors are advised to use their power wisely, not wildly.

# Chapter 14. Text Properties

Sure, a lot of web design involves picking the right colors and getting the coolest look for your pages, but when it comes right down to it, you probably spend more of your time worrying about where text will go and how it will look. Such concerns gave rise to HTML tags such as `<FONT>` and `<CENTER>`, which allow you some measure of control over the appearance and placement of text.

Because text is so important, there are many CSS properties that affect it in one way or another. What is the difference between text and fonts? Simply, text is the content, and fonts are used to display that content. Using text properties, you can affect the position of text in relation to the rest of the line, superscript it, underline it, and change the capitalization. You can even simulate, to a limited degree, the use of a typewriter's Tab key.

# **Indentation and Horizontal Alignment**

Let's start with a discussion of how you can affect the horizontal positioning of text within a line. Think of these basic actions as the same types of steps you might take to create a newsletter or write a report.

# Indenting Text

Indenting the first line of a paragraph on a web page is one of the most sought-after text-formatting effects. (Eliminating the blank line between paragraphs is a close second.) Some sites used to create the illusion of indented text by placing a small transparent image before the first letter in a paragraph, which shoved the text over. Thanks to CSS, there's a much better way to indent text: `text-indent`.

## **text-indent**

*Values:*

`<length>` | `<percentage>` | `inherit`

*Initial value:*

0

*Applies to:*

Block-level elements

*Inherited:*

Yes

*Percentages:*

Refer to the width of the containing block

*Computed value:*

For percentage values, as specified; for length values, the absolute length

Using `text-indent`, the first line of any element can be indented by a given length—even if that length is negative. The most common use for this property is, of course, to indent the first line of a paragraph:

```
p {text-indent: 3em;}
```

This rule will cause the first line of any paragraph to be indented three ems, as shown in [Figure 14-1](#).

This is a paragraph element, which means that the first line will be indented by 3em (i.e., three times the computed `font-size` of the text in the paragraph). The other lines in the paragraph will not be indented, no matter how long the paragraph may be.

**Figure 14-1.** Text indenting

In general, you can apply `text-indent` to any block-level element. You can't apply it to inline elements or on replaced elements such as images. However, if you have an image within the first line of a block-level element, like a paragraph, it will be shifted over with the rest of the text in the line.

**Note**

If you want to “indent” the first line of an inline element, you can create the effect with left padding or margin.

You can also set negative values for `text-indent`, a technique that leads to a number of interesting effects. The most common use is a “hanging indent,” where the first line hangs out to the left of the rest of the element:

```
p {text-indent: -4em;}
```

Be careful when setting a negative value for `text-indent`; the first three words (“This is a”) may be chopped off by the left edge of the browser window. To avoid display problems, I recommend you use a margin or some padding to accommodate the negative indentation:

```
p {text-indent: -4em; padding-left: 4em;}
```

Negative indents can, however, be used to your advantage. Consider the following example, demonstrated in [Figure 14-2](#), which adds a floated image to the mix:

```
p.hang {text-indent: -25px;}
```



```

<p class="hang"> This paragraph has a negatively indented first line, which overlaps the floated image that precedes the text. Subsequent lines do not overlap the image, since they are not indented in any way.
```

This paragraph has a negatively indented first line, which overlaps the floated image that precedes the text. Subsequent lines do not overlap the image, since they are not indented in any way.

**Figure 14-2. A floated image and negative text indenting**

A variety of interesting designs can be achieved using this simple technique.

Any unit of length, including percentage values, may be used with `text-indent`. In the following case, the percentage refers to the width of the parent element of the element being indented. In other words, if you set the indent value to 10%, the first line of an affected element will be indented by 10 percent of its parent element's width, as shown in [Figure 14-3](#):

```
div {width: 400px; }
p {text-indent: 10%;}

<div>
<p>This paragraph is contained inside a DIV, which is 400px wide, first line of the paragraph is indented 40px ( $400 * 10\% = 40$ ). T because percentages are computed with respect to the width of the
</div>
```

This paragraph is contained inside a DIV, which is 400px wide, so the first line of the paragraph is indented 40px ( $400 * 10\% = 40$ ). This is because percentages are computed with respect to the width of the element.

**Figure 14-3. Text indenting with percentages**

Note that this indentation only applies to the first line of an element, even if you insert line breaks. The interesting part about `text-indent` is that because it's inherited, it can have unexpected effects. For example, consider the following markup, which is illustrated in [Figure 14-4](#):

```
div#outer {width: 500px;}  
div#inner {text-indent: 10%;}  
p {width: 200px;}  
  
<div id="outer">  
<div id="inner">  
This first line of the DIV is indented by 50 pixels.  
<p>  
This paragraph is 200px wide, and the first line of the paragraph  
is indented 50px. This is because computed values for 'text-indent'  
are inherited, instead of the declared values.  
</p>  
</div>  
</div>
```

This first line of the DIV is indented by 50 pixels.

This paragraph is  
200px wide, and the first line  
of the paragraph is indented  
50px. This is because  
computed values for  
`text-indent` are inherited,  
instead of the declared values.

**Figure 14-4. Inherited text indenting**

# Horizontal Alignment

Even more basic than `text-indent` is the property `text-align`, which affects how the lines of text in an element are aligned with respect to one another.

## `text-align`

*CSS 2.1 values:*

`left | center | right | justify | inherit`

*CSS3 values:*

`[ [ start | end | left | right | center ] || <_string_> ] | justify |  
match-parent | start end | inherit`

*Initial value:*

In CSS3, `start`; in CSS 2.1, user agent-specific, likely depending on writing direction

*Applies to:*

Block-level elements

*Inherited:*

Yes

*Computed value:*

As specified, except in the case of `match-parent`

*Note:*

CSS2 included a `<_string_>` value that was dropped from CSS 2.1 due

to a lack of implementation

The quickest way to understand how these values work is to examine [Figure 14-5](#), which sticks with three of the CSS 2.1 values for the moment.

This paragraph is styled `text-align: left;`, which causes the line boxes within the element to line up along the left inner content edge of the paragraph.

This paragraph is styled `text-align: right;`, which causes the line boxes within the element to line up along the right inner content edge of the paragraph.

This paragraph is styled `text-align: center;`, which causes the line boxes within the element to line up their centers with the center of the content area of the paragraph.

**Figure 14-5.** Selected behaviors of the `text-align` property

Obviously, the values `left`, `right`, and `center` cause the text within elements to be aligned exactly as described. Because `text-align` applies only to block-level elements, such as paragraphs, there's no way to center an anchor within its line without aligning the rest of the line (nor would you want to, since that would likely cause text overlap).

Historically, which is to say under CSS 2.1 rules, the default value of `text-align` is `left` in left-to-right languages, and `right` in right-to-left languages. (CSS 2.1 had no notion of vertical writing modes.) In CSS3, `left` and `right` are mapped to the start or end edge, respectively, of a vertical language. This is illustrated in [Figure 14-6](#).

As you no doubt expect, `center` causes each line of text to be centered within the element. Although you may be tempted to believe that `text-align: center` is the same as the `<CENTER>` element, it's actually quite different. `<CENTER>` affected not only text, but also centered whole elements, such as tables. `text-align` does not control the alignment of elements, only their inline content. Figures [Figure 14-5](#) and [Figure 14-6](#) illustrate this clearly in various writing directions.

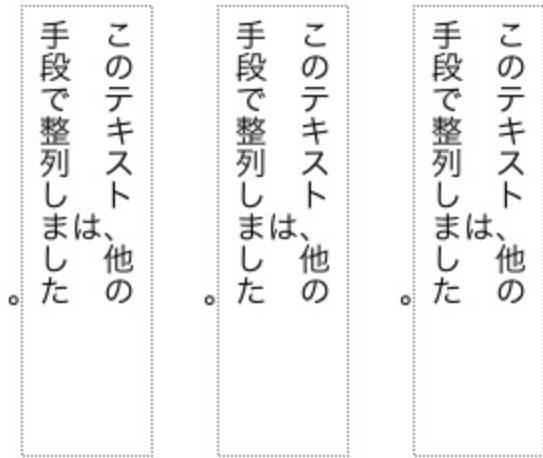


Figure 14-6. Left, right, and center in vertical writing modes

## Start and end alignment

CSS3 (which is to say, the “CSS Text Module Level 3” specification) added a number of new values to `text-align`, and even changed the default property value as compared to CSS 2.1.

The new default value of `start` means that the text is aligned to the start edge of its line box. In left-to-right languages like English, that’s the left edge; in right-to-left languages such as Hebrew, it’s the right edge. In vertical languages, for that matter, it will be the top or bottom, depending on the writing direction. The upshot is that the default value is much more aware of the document’s language direction while leaving the default behavior the same in the vast majority of existing cases.

In a like manner, `end` aligns text with the end edge of each line box—the right edge in LTR languages, the left edge in RTL languages, and so forth. The effects of these values are shown in [Figure 14-7](#).

This paragraph is start-aligned, which causes the line boxes within the element to line up along the start edge of the paragraph.

هذه الفقرة هي بداية الانحياز، الذي يتسبب في صناديق خط داخل عنصر يمتصطف على طول حافة بداية الفقرة.

This paragraph is end-aligned, which causes the line boxes within the element to line up along the end edge of the paragraph.

פסקה זו היא הסוף מודרנה, מה שגורם את תיבות השורה בתוך הרכיב בשורה לאורך קצה סוף הפסקה.

**Figure 14-7. Start and end alignment**

And then there's the value `start end`, which is declared like so:

```
p {text-align: start end;}
```

This is a fascinating, and so far unsupported, value of `text-align`. The effect is that the first line of the element, as well as any line that immediately follows a line break, uses `start` alignment. The rest of the lines in the element use `end` alignment. (It may be dropped from the CSS3 module if nobody starts supporting it.)

## Justified text

An often-overlooked alignment property is `justify`, which raises some issues of its own. In justified text, both ends of a line of text are placed at the inner edge of the parent element, as [Figure 14-8](#) shows. Then, the spacing between words and letters is adjusted so that each line is precisely the same length. Justified text is common in the print world (for example, in this book), but under CSS, a few extra considerations come into play.

This paragraph is styled `text-align: justify;`, which causes the line boxes within the element to align their left and right edges to the left and right inner content edges of the paragraph. The exception is the last line box, whose right edge does not align with the right content edge of the paragraph. (In right-to-left languages, the left edge of the last line box would not be so aligned.)

This paragraph is styled `text-align: justify;`, which causes the line boxes within the element to align their left and right edges to the left and right inner content edges of the paragraph. The exception is the last line box, whose right edge does not align with the right content edge of the paragraph. (In right-to-left languages, the left edge of the last line box would not be so aligned.)

**Figure 14-8. Justified text**

The user agent—and not CSS, at least as of mid-2013—determines how justified text should be stretched to fill the space between the left and right

edges of the parent. Some browsers, for example, might add extra space only between words, while others might distribute the extra space between letters (although the CSS specification states that “user agents may not further increase or decrease the inter-character space” if the property `letter-spacing` has been assigned a length value). Other user agents may reduce space on some lines, thus mashing the text together a bit more than usual. All of these possibilities will affect the appearance of an element, and may even change its height, depending on how many lines of text result from the user agent’s justification choices.

## String alignment

String alignment is an interesting case, one that has been lurking throughout the history of CSS without actually gaining traction. The easiest way to explain it is to show some code and the results ([Figure 14-9](#)):

```
table[summary="Daily Sales"] th {text-align: "/"; }
table[summary="Daily Sales"] td {text-align: "."; }

<table summary="Daily Sales">
<tr><th>Mon 4/8</th><td>$12,122.13</td></tr>
<tr><th>Tue 4/9</th><td>$13,729.10</td></tr>
<tr><th>Wed 4/10</th><td>$9,447</td></tr>
<tr><th>Thu 4/11</th><td>$10,308.76</td></tr>
<tr><th>Fri 4/12</th><td>$999.99</td></tr>
</table>
```

<b>Mon 4/8</b>	<b>\$12,122.13</b>
<b>Tue 4/9</b>	<b>\$13,729.10</b>
<b>Wed 4/10</b>	<b>\$9,447</b>
<b>Thu 4/11</b>	<b>\$10,308.76</b>
<b>Fri 4/12</b>	<b>\$999.99</b>

**Figure 14-9. String alignment**

As [Figure 14-9](#) shows, all the cells’ contents are aligned such that the “.” characters line up along a vertical line (since this is a horizontal language).

Had the CSS actually been `text-align: ", "` then the cells would all have lined up on the commas.

#### Note

The problem, as always, is that string alignment still isn't supported by browsers, and may be once again dropped from the specification. ([Figure 14-9](#) was faked, I'm sorry to say.)

## Parent matching

There's one more value to be covered, which is `match-parent`. This isn't supported by browsers, but its intent is mostly covered by `inherit` anyway. The idea is, if you declare `text-align: match-parent`, the alignment of the element will match the alignment of its parent. So far, that sounds exactly like `inherit`, but there's a difference: if the parent's alignment value is `start` or `end`, the result of `match-parent` is to assign a computed value of `left` or `right` to the element. That wouldn't happen with `inherit`, which would simply apply `start` or `end` to the element with no changes.

# Aligning the Last Line

There may be times when you want to align the text in the very last line of an element differently than you did the rest of the content. For example, you might left-align the last line of an otherwise fully justified block of text, or choose to swap from left to center alignment. For those situations, there is `text-align-last`.

## **text-align-last**

*Values:*

`auto | start | end | left | right | center | justify`

*Initial value:*

`auto`

*Applies to:*

Block-level elements

*Inherited:*

Yes

*Computed value:*

As specified

As with `text-align`, the quickest way to understand how these values work is to examine [Figure 14-10](#).

This paragraph has its "last" lines aligned to the start. This alignment will be seen immediately preceding line breaks: and also in the very last line of text in the paragraph, wherever that may happen to fall.	This paragraph has its "last" lines aligned to the end. This alignment will be seen immediately preceding line breaks: and also in the very last line of text in the paragraph, wherever that may happen to fall.
This paragraph has its "last" lines aligned to the left. This alignment will be seen immediately preceding line breaks: and also in the very last line of text in the paragraph, wherever that may happen to fall.	This paragraph has its "last" lines aligned to the right. This alignment will be seen immediately preceding line breaks: and also in the very last line of text in the paragraph, wherever that may happen to fall.
This paragraph has its "last" lines aligned to the center. This alignment will be seen immediately preceding line breaks: and also in the very last line of text in the paragraph, wherever that may happen to fall.	

**Figure 14-10. Differently aligned last lines**

As you can see, the last lines of the elements are aligned independently of the rest of the elements, according to the elements' `text-align-last` values.

A close study of [Figure 14-10](#) will reveal that there's more at play than just the last lines of block-level elements. In fact, `text-align-last` applies to any line of text that immediately precedes a forced line break, whether or not said line break is triggered by the end of an element. Thus, a line break occasioned by a `<br>` tag will make the line of text immediately before that break use the value of `text-align-last`. So too will the last line of text in a block-level element, since a line break is generated by the element's closure.

There are two more interesting wrinkles in `text-align-last`. The first is that if the first line of text in an element is also the last line of text in the element, then the value of `text-align-last` takes precedence over the value of `text-align`. Thus, the following styles will result in a centered paragraph, not a start-aligned paragraph:

```
p {text-align: start; text-align-last: center;}

<p>A paragraph.</p>
```

The second, closely related, wrinkle is that `text-align-last` is ignored if the element's `text-align` value is `start` or `end`. In other words, in the following case, the text will *not* be centered:

```
p {text-align: START end; text-align-last: center;}

<p>A paragraph.</p>
```

#### Note

As of mid-2013, support for `text-align-last` was limited to a prefixed Gecko property, `-moz-text-align-last`.

# Vertical Alignment

Now that we've covered horizontal alignment, let's move on to vertical alignment. Since the construction of lines is a very complex topic that merits its own small book, I'll just stick to a quick overview here.

# The Height of Lines

The `line-height` property refers to the distance between the baselines of lines of text rather than the size of the font, and it determines the amount by which the height of each element's box is increased or decreased. In the most basic cases, specifying `line-height` is a way to increase (or decrease) the vertical space between lines of text, but this is a misleadingly simple way of looking at how `line-height` works. `line-height` controls the *leading*, which is the extra space between lines of text above and beyond the font's size. In other words, the difference between the value of `line-height` and the size of the font is the leading.

## **line-height**

*Values:*

`<length>` | `<percentage>` | `<number>` | `normal` | `inherit`

*Initial value:*

`normal`

*Applies to:*

All elements (but see text regarding replaced and block-level elements)

*Inherited:*

Yes

*Percentages:*

Relative to the font size of the element

*Computed value:*

For length and percentage values, the absolute value; otherwise, as specified

When applied to a block-level element, `line-height` defines the minimum distance between text baselines within that element. Note that it defines a minimum, not an absolute value, and baselines of text can wind up being pushed further apart than the value of `line-height`. `line-height` does not affect layout for replaced elements, but it still applies to them.

## Constructing a line

Every element in a line of text generates a *content area*, which is determined by the size of the font. This content area in turn generates an *inline box* that is, in the absence of any other factors, exactly equal to the content area. The leading generated by `line-height` is one of the factors that increases or decreases the height of each inline box.

To determine the leading for a given element, simply subtract the computed value of `font-size` from the computed value of `line-height`. That value is the total amount of leading. And remember, it can be a negative number. The leading is then divided in half, and each half-leading is applied to the top and bottom of the content area. The result is the inline box for that element.

As an example, let's say the `font-size` (and therefore the content area) is 14 pixels tall, and the `line-height` is computed to 18 pixels. The difference (4 pixels) is divided in half, and each half is applied to the top and bottom of the content area. This creates an inline box that is 18 pixels tall, with 2 extra pixels above and below the content area. This sounds like a roundabout way to describe how `line-height` works, but there are excellent reasons for the description.

Once all of the inline boxes have been generated for a given line of content, they are then considered in the construction of the line box. A line box is exactly as tall as needed to enclose the top of the tallest inline box and the bottom of the lowest inline box. [Figure 14-11](#) shows a diagram of this process.

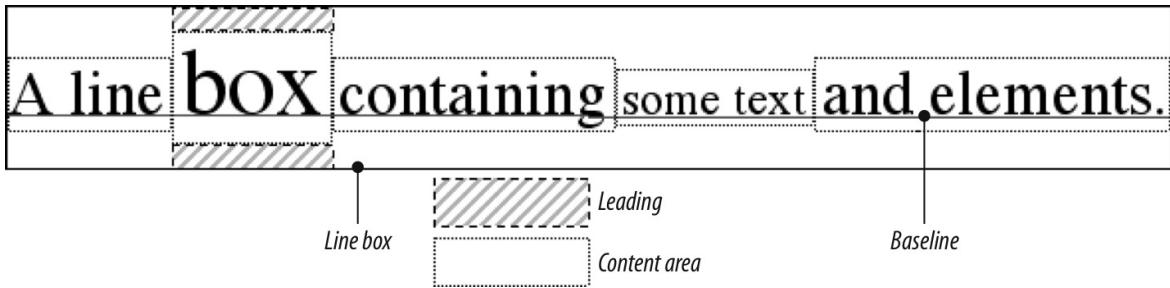


Figure 14-11. Line box diagram

## Assigning values to line-height

Let's now consider the possible values of `line-height`. If you use the default value of `normal`, the user agent must calculate the vertical space between lines. Values can vary by user agent, but they're generally 1.2 times the size of the font, which makes line boxes taller than the value of `font-size` for a given element.

Most values are simple length measures (e.g., `18px` or `2em`). Be aware that even if you use a valid length measurement, such as `4cm`, the browser (or the operating system) may be using an incorrect metric for real-world measurements, so the line height may not show up as exactly four centimeters on your monitor.

`em`, `ex`, and percentage values are calculated with respect to the `font-size` of the element. The markup is relatively straightforward, and the results are shown in [Figure 14-12](#):

```
body {line-height: 18px; font-size: 16px;}
p.c11 {line-height: 1.5em;}
p.c12 {font-size: 10px; line-height: 150%;}
p.c13 {line-height: 0.33in;}

<p>This paragraph inherits a 'line-height' of 14px from the body,  
a 'font-size' of 13px.</p>
<p class="c11">This paragraph has a 'line-height' of 27px(18 * 1.  
it will have slightly more line-height than usual.</p>
<p class="c12">This paragraph has a 'line-height' of 15px (10 * 1  
it will have slightly more line-height than usual.</p>
<p class="c13">This paragraph has a 'line-height' of 0.33in, so i  
slightly more line-height than usual.</p>
```

This paragraph inherits a 'line-height' of 18px from the body, as well as a 'font-size' of 16px.

This paragraph has a 'line-height' of 27px( $18 * 1.5$ ), so it will have slightly more line-height than usual.

This paragraph has a 'line-height' of 15px ( $10 * 150\%$ ), so it will have slightly more line-height than usual.

This paragraph has a 'line-height' of 0.33in, so it will have slightly more line-height than usual.

**Figure 14-12. Simple calculations with the line-height property**

## Line-height and inheritance

When the `line-height` is inherited by one block-level element from another, things get a bit trickier. `line-height` values inherit from the parent element as computed from the parent, not the child. The results of the following markup are shown in [Figure 14-13](#). It probably wasn't what the author had in mind:

```
body {font-size: 10px;}  
div {line-height: 1em;} /* computes to '10px' */  
p {font-size: 18px;}  
  
<div>  
<p>This paragraph's 'font-size' is 18px, but the inherited 'line-height' value is only 10px. This may cause the lines of text to overlap other by a small amount.</p>  
</div>
```

This paragraph's 'font-size' is 18px, but the inherited 'line-height' value is only 10px. This may cause the lines of text to overlap each other by a small amount.

**Figure 14-13. Small line-height, large font-size, slight problem**

Why are the lines so close together? Because the computed `line-height` value of 10px was inherited by the paragraph from its parent `div`. One solution to the small `line-height` problem depicted in [Figure 14-13](#) is to set an explicit `line-height` for every element, but that's not very practical. A better alternative is to specify a number, which actually sets a scaling factor:

```
body {font-size: 10px;}  
div {line-height: 1;}  
p {font-size: 18px;}
```

When you specify a number, you cause the scaling factor to be an inherited value instead of a computed value. The number will be applied to the element and all of its child elements, so that each element has a `line-height` calculated with respect to its own `font-size` (see [Figure 14-14](#)):

```
div {line-height: 1.5;}  
p {font-size: 18px;}  
  
<div>  
<p>This paragraph's 'font-size' is 18px, and since the 'line-height' set for the parent div is 1.5, the 'line-height' for this paragraph is 27px (18 * 1.5).</p>  
</div>
```

This paragraph's 'font-size' is 18px, and since the 'line-height' set for the parent div is 1.5, the 'line-height' for this paragraph is 27px (18 \* 1.5).

**Figure 14-14. Using line-height factors to overcome inheritance problems**

Though it seems like `line-height` distributes extra space both above and below each line of text, it actually adds (or subtracts) a certain amount from the top and bottom of an inline element's content area to create an inline box. Assume that the default `font-size` of a paragraph is 12pt and consider the following:

```
p {line-height: 16pt;}
```

Since the “inherent” line height of 12-point text is 12 points, the preceding rule will place an extra 4 points of space around each line of text in the paragraph. This extra amount is divided in two, with half going above each line and the other half below. You now have 16 points between the baselines, which is an indirect result of how the extra space is apportioned.

If you specify the value `inherit`, then the element will use the computed value for its parent element. This isn't really any different than allowing the value to inherit naturally, except in terms of specificity and cascade resolution.

Now that you have a basic grasp of how lines are constructed, let's talk about vertically aligning elements relative to the line box.

# Vertically Aligning Text

If you've ever used the elements `sup` and `sub` (the superscript and subscript elements), or used an image with markup such as ``, then you've done some rudimentary vertical alignment. In CSS, the `vertical-align` property applies only to inline elements and replaced elements such as images and form inputs. `vertical-align` is not an inherited property.

## **vertical-align**

*Values:*

`baseline | sub | super | top | text-top | middle | bottom | text-bottom  
| <percentage> | <length> | inherit`

*Initial value:*

`baseline`

*Applies to:*

Inline elements and table cells

*Inherited:*

No

*Percentages:*

Refer to the value of `line-height` for the element

*Computed value:*

For percentage and length values, the absolute length; otherwise, as specified

*Note:*

When applied to table cells, only the values `baseline`, `top`, `middle`, and `bottom` are recognized

`vertical-align` accepts any one of eight keywords, a percentage value, or a length value. The keywords are a mix of the familiar and unfamiliar: `baseline` (the default value), `sub`, `super`, `bottom`, `text-bottom`, `middle`, `top`, and `text-top`. We'll examine how each keyword works in relation to inline elements.

#### **Warning**

Remember: `vertical-align` does *not* affect the alignment of content within a block-level element. You can, however, use it to affect the vertical alignment of elements within table cells.

## **Baseline alignment**

`vertical-align: baseline` forces the baseline of an element to align with the baseline of its parent. Browsers, for the most part, do this anyway, since you'd obviously expect the bottoms of all text elements in a line to be aligned.

If a vertically aligned element doesn't have a baseline—that is, if it's an image, a form input, or another replaced element—then the bottom of the element is aligned with the baseline of its parent, as [Figure 14-15](#) shows:

```
img {vertical-align: baseline;}
```

```
<p>The image found in this paragraph  has its bottom edge aligned with the baseline of the text in the paragraph.
```

The image found in this paragraph • has its bottom edge aligned with the baseline of the text in the paragraph.

**Figure 14-15. Baseline alignment of an image**

This alignment rule is important because it causes some web browsers to always put a replaced element's bottom edge on the baseline, even if there is no other text in the line. For example, let's say you have an image in a table cell all by itself. The image may actually be on a baseline, but in some browsers, the space below the baseline causes a gap to appear beneath the image. Other browsers will "shrink-wrap" the image with the table cell, and no gap will appear. The gap behavior is correct, according to the CSS Working Group, despite its lack of appeal to most authors.

**Note**

See the aged and yet still relevant article "["Images, Tables, and Mysterious Gaps"](#)" for a more detailed explanation of gap behavior and ways to work around it.

## Superscripting and subscripting

The declaration `vertical-align: sub` causes an element to be subscripted, meaning that its baseline (or bottom, if it's a replaced element) is lowered with respect to its parent's baseline. The specification doesn't define the distance the element is lowered, so it may vary depending on the user agent.

`super` is the opposite of `sub`; it raises the element's baseline (or bottom of a replaced element) with respect to the parent's baseline. Again, the distance the text is raised depends on the user agent.

Note that the values `sub` and `super` do *not* change the element's font size, so subscripted or superscripted text will not become smaller (or larger). Instead, any text in the `sub-` or superscripted element should be, by default, the same size as text in the parent element, as illustrated by [Figure 14-16](#):

```
span.raise {vertical-align: super;}  
span.lower {vertical-align: sub;}
```

```
<p>This paragraph contains <span class="raise">superscripted</span>  
and <span class="lower">subscripted</span> text.</p>
```

This paragraph contains <sup>superscripted</sup> and <sub>subscripted</sub> text.

**Figure 14-16. Superscript and subscript alignment**

**Note**

If you wish to make super- or subscripted text smaller than the text of its parent element, you can do so using the property `font-size`.

## Bottom feeding

`vertical-align: bottom` aligns the bottom of the element's inline box with the bottom of the line box. For example, the following markup results in [Figure 14-17](#):

```
.feeder {vertical-align: bottom;}  
  
<p>This paragraph, as you can see quite clearly, contains  
a  image and  
a  image,  
and then some text that is not tall.</p>
```

This paragraph, as you can see quite clearly,

contains a  image and a  image, and then  
some text which is not tall.

**Figure 14-17. Bottom alignment**

The second line of the paragraph in [Figure 14-17](#) contains two inline elements, whose bottom edges are aligned with each other. They're also below the baseline of the text.

`vertical-align: text-bottom` refers to the bottom of the text in the line. For the purposes of this value, replaced elements, or any other kinds of non-text elements, are ignored. Instead, a “default” text box is considered. This default box is derived from the `font-size` of the parent element. The bottom of the aligned element’s inline box is then aligned with the bottom of the default text box. Thus, given the following markup, you get a result like the one shown in [Figure 14-18](#):

```
img.tbot {vertical-align: text-bottom; }

<p>Here: a 
```

Here: a  image, and then a  image.

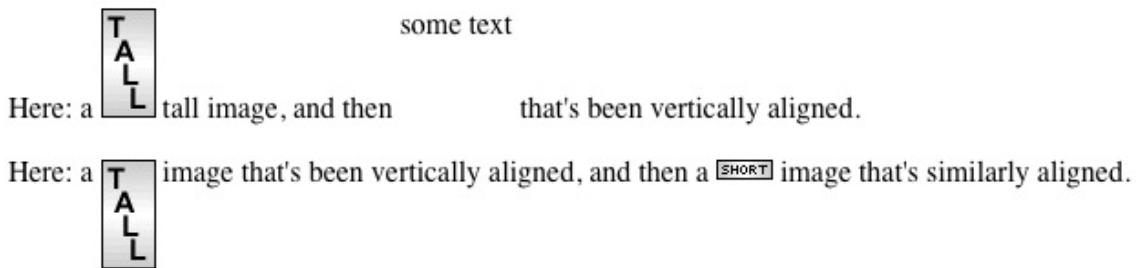
**Figure 14-18.** Text-bottom alignment

## Getting on top

Employing `vertical-align: top` has the opposite effect of `bottom`. Likewise, `vertical-align: text-top` is the reverse of `text-bottom`. [Figure 14-19](#) shows how the following markup would be rendered:

```
.up {vertical-align: top; }
.textup {vertical-align: text-top; }

<p>Here: a  tall image, and
<span class="up">some text</span> that's been vertically aligned.
<p>Here: a  image t
vertically aligned, and then a 
```

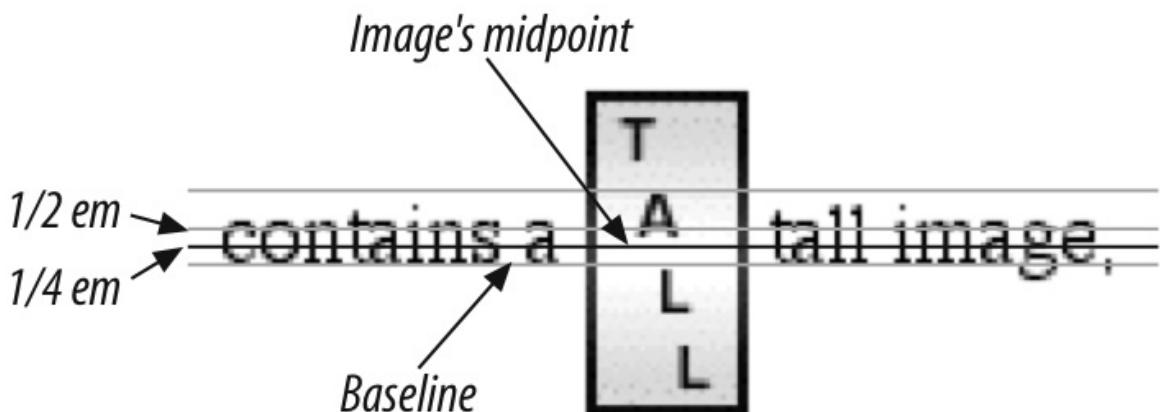


**Figure 14-19. Aligning with the top and text-top of a line**

Of course, the exact position of this alignment will depend on which elements are in the line, how tall they are, and the size of the parent element’s font.

## In the middle

There’s the value `middle`, which is usually (but not always) applied to images. It does not have the exact effect you might assume given its name. `middle` aligns the middle of an inline element’s box with a point that is  $0.5\text{ex}$  above the baseline of the parent element, where  $\text{1ex}$  is defined relative to the `font-size` for the parent element. [Figure 14-20](#) shows this in more detail.



**Figure 14-20. Precise detail of middle alignment**

Since most user agents treat  $\text{1ex}$  as one-half  $\text{em}$ , `middle` usually aligns the vertical midpoint of an element with a point one-quarter  $\text{em}$  above the parent’s baseline, though this is not a defined distance and so can vary from

one user agent to another.

# Percentages

Percentages don't let you simulate `align="middle"` for images. Instead, setting a percentage value for `vertical-align` raises or lowers the baseline of the element (or the bottom edge of a replaced element) by the amount declared, with respect to the parent's baseline. (The percentage you specify is calculated as a percentage of `line-height` for the element, *not* its parent.) Positive percentage values raise the element, and negative values lower it. Depending on how the text is raised or lowered, it can appear to be placed in adjacent lines, as shown in [Figure 14-21](#), so take care when using percentage values:

```
sub {vertical-align: -100%;}  
sup {vertical-align: 100%;}  
  
<p>We can either <sup>soar to new heights</sup> or, instead,  
<sub>sink into despair...</sub></p>
```

soar to new heights  
We can either or , instead,  
sink into despair...

**Figure 14-21.** Percentages and fun effects

Let's consider percentage values in more detail. Assume the following:

I felt that, if nothing else, I deserved a raise for my efforts.

The 50%-aligned `span` element has its baseline raised nine pixels, which is half of the element's inherited `line-height` value of `18px`, *not* seven pixels.

## Length alignment

Finally, let's consider vertical alignment with a specific length. `vertical-align` is very straightforward: it shifts an element up or down by the declared distance. Thus, `vertical-align: 5px;` will shift an element upward five pixels from its unaligned placement. Negative length values shift the element downward. This simple form of alignment did not exist in CSS1, but it was added in CSS2.

It's important to realize that vertically aligned text does not become part of another line, nor does it overlap text in other lines. Consider [Figure 14-22](#), in which some vertically aligned text appears in the middle of a paragraph.

This paragraph contains a lot of text to be displayed, and a part of that text is  
**nicely bold text**

some which is raised up 100%. This makes it look as though the bold text is part of its own line of text, when in fact the line in which it sits is simply much taller than usual.

**Figure 14-22. Vertical alignments can cause lines to get taller**

As you can see, any vertically aligned element can affect the height of the line. Recall the description of a line box, which is exactly as tall as necessary to enclose the top of the tallest inline box and the bottom of the lowest inline box. This includes inline boxes that have been shifted up or down by vertical alignment.

# Word Spacing and Letter Spacing

Now that we've dealt with alignment, let's look at manipulating word and letter spacing. As usual, these properties have some nonintuitive issues.

# Word Spacing

The `word-spacing` property accepts a positive or negative length. This length is *added* to the standard space between words. In effect, `word-spacing` is used to *modify* inter-word spacing. Therefore, the default value of `normal` is the same as setting a value of zero (0).

## **word-spacing**

*Values:*

`<length>` | `normal` | `inherit`

*Initial value:*

`normal`

*Applies to:*

All elements

*Inherited:*

Yes

*Computed value:*

For `normal`, the absolute length 0; otherwise, the absolute length

If you supply a positive length value, then the space between words will increase. Setting a negative value for `word-spacing` brings words closer together:

```
p.spread {word-spacing: 0.5em;}  
p.tight {word-spacing: -0.5em;}  
p.base {word-spacing: normal;}  
p.norm {word-spacing: 0;}
```

```
<p class="spread">The spaces between words in this paragraph will  
  by 0.5em.</p>  
<p class="tight">The spaces between words in this paragraph will  
  by 0.5em.</p>  
<p class="base">The spaces between words in this paragraph will b  
<p class="norm">The spaces between words in this paragraph will b
```

Manipulating these settings has the effect shown in [Figure 14-23](#).

The spaces between words in this paragraph will be increased by 0.5em.

The space between words in this paragraph will be decreased by 0.5em.

The spaces between words in this paragraph will be normal.

The spaces between words in this paragraph will be normal.

**Figure 14-23. Changing the space between words**

So far, I haven't actually given you a precise definition of "word." In the simplest CSS terms, a "word" is any string of nonwhitespace characters that is surrounded by whitespace of some kind. This definition has no real semantic meaning; it simply assumes that a document contains words surrounded by one or more whitespace characters. A CSS-aware user agent cannot be expected to decide what is a valid word in a given language and what isn't. This definition, such as it is, means `word-spacing` is unlikely to work in any languages that employ pictographs, or non-Roman writing styles. The property allows you to create very unreadable documents, as [Figure 14-24](#) makes clear. Use `word-spacing` with care.

The                spaces                between                words                in  
this                paragraph            will                be                increased  
by                 one                 inch.                Room                enough  
for                ya?

**Figure 14-24. Really wide word spacing**

# Letter Spacing

Many of the issues you encounter with `word-spacing` also occur with `letter-spacing`. The only real difference between the two is that `letter-spacing` modifies the space between characters, or letters.

## **letter-spacing**

### Values

`<length>` | `normal` | `inherit`

### Initial value

`normal`

### Applies to

All elements

### Inherited

Yes

### Computed value

For length values, the absolute length; otherwise, `normal`

As with the `word-spacing` property, the permitted values of `letter-spacing` include any length. The default keyword is `normal` (making it the same as `letter-spacing: 0`). Any length value you enter will increase or decrease the space between letters by that amount. [Figure 14-25](#) shows the results of the following markup:

```
p {letter-spacing: 0;}      /* identical to 'normal' */
p.spacious {letter-spacing: 0.25em;}
p.tight {letter-spacing: -0.25em;}
```

```
<p>The letters in this paragraph are spaced as normal.</p>
<p class="spacious">The letters in this paragraph are spread out
<p class="tight">The letters in this paragraph are a bit smashed
```

The letters in this paragraph are spaced as normal.

The letters in this paragraph are spread out a bit.

~~This paragraph is smashed~~

**Figure 14-25. Various kinds of letter spacing**

Using letter-spacing to increase emphasis is a time-honored technique. You might write the following declaration and get an effect like the one shown in [Figure 14-26](#):

```
strong {letter-spacing: 0.2em;}
```

```
<p>This paragraph contains <strong>strongly emphasized text</strong>
that is spread out for extra emphasis.</p>
```

This paragraph contains **strongly emphasized text** which is spread out for extra emphasis.

**Figure 14-26. Using letter-spacing to increase emphasis**

#### Note

If a page uses fonts with features like ligatures, and those features are enabled, then altering letter- or word-spacing can effectively disable them. Browsers will not re-calculate ligatures or other joins when letter spacing is altered, for example.

# Spacing and Alignment

The value of `word-spacing` may be influenced by the value of the property `text-align`. If an element is justified, the spaces between letters and words may be altered to fit the text along the full width of the line. This may in turn alter the spacing declared by the author with `word-spacing`. If a length value is assigned to `letter-spacing`, then it cannot be changed by `text-align`, but if the value of `letter-spacing` is `normal`, then inter-character spacing may be changed in order to justify the text. CSS does not specify how the spacing should be calculated, so user agents simply fill it in.

As usual, the child of an element inherits the computed value of that element. You cannot define a scaling factor for `word-spacing` or `letter-spacing` to be inherited in place of the computed value (as is the case with `line-height`). As a result, you may run into problems such as those shown in [Figure 14-27](#):

```
p {letter-spacing: 0.25em; font-size: 20px;}  
small {font-size: 50%;}
```

```
<p>This spacious paragraph features <small>tiny text that is just  
as spacious</small>, even though the author probably wanted the  
spacing to be in proportion to the size of the text.</p>
```

This spacious paragraph features tiny text which is just as spacious, even though the author probably wanted the spacing to be in proportion to the size of the text.

**Figure 14-27. Inherited letter spacing**

The only way to achieve letter spacing that's in proportion to the size of the text is to set it explicitly, as follows:

```
p {letter-spacing: 0.25em;}  
small {font-size: 50%; letter-spacing: 0.25em;}
```

# Text Transformation

Now let's look at ways to manipulate the capitalization of text using the property `text-transform`.

## **text-transform**

### Values

`uppercase` | `lowercase` | `capitalize` | `none` | `inherit`

### Initial value

`none`

### Applies to

All elements

### Inherited

Yes

### Computed value

As specified

The default value `none` leaves the text alone and uses whatever capitalization exists in the source document. As their names imply, `uppercase` and `lowercase` convert text into all upper- or lowercase characters. Finally, `capitalize` capitalizes only the first letter of each word. [Figure 14-28](#) illustrates each of these settings in a variety of ways:

```
h1 {text-transform: capitalize;}  
strong {text-transform: uppercase;}  
p.cummings {text-transform: lowercase;}  
p.raw {text-transform: none;}
```

```
<h1>The heading-one at the beginninG</h1>
<p> By default, text is displayed in the capitalization it has in
document, but <strong>it is possible to change this</strong> usin
the property 'text-transform'.
</p>
<p class="cummings">
For example, one could Create TEXT such as might have been Writte
the late Poet e.e.cummings.
</p>
<p class="raw">
If you feel the need to Explicitly Declare the transformation of
to be 'none', that can be done as well.
</p>
```

## The Heading-one At The BeginninG

By default, text is displayed in the capitalization it has in the source document, but **IT IS POSSIBLE TO CHANGE THIS** using the property 'text-transform'.

for example, one could create text such as might have been written by the late poet e.e.cummings.

If you feel the need to Explicitly Declare the transformation of text to be 'none', that can be done as well.

**Figure 14-28.** Various kinds of text transformation

Different user agents may have different ways of deciding where words begin and, as a result, which letters are capitalized. For example, the text “heading-one” in the h1 element, shown in [Figure 14-28](#), could be rendered in one of two ways: “Heading-one” or “Heading-One.” CSS does not say which is correct, so either is possible.

You probably also noticed that the last letter in the h1 element in [Figure 14-28](#) is still uppercase. This is correct: when applying a text-transform of capitalize, CSS only requires user agents to make sure the first letter of each word is capitalized. They can ignore the rest of the word.

As a property, text-transform may seem minor, but it’s very useful if you

suddenly decide to capitalize all your `h1` elements. Instead of individually changing the content of all your `h1` elements, you can just use `text-transform` to make the change for you:

```
h1 {text-transform: uppercase;}  
<h1>This is an H1 element</h1>
```

The advantages of using `text-transform` are twofold. First, you only need to write a single rule to make this change, rather than changing the `h1` itself. Second, if you decide later to switch from all capitals back to initial capitals, the change is even easier, as [Figure 14-29](#) shows:

```
h1 {text-transform: capitalize;}  
<h1>This is an H1 element</h1>
```

# This Is An H1 Element

**Figure 14-29.** Transforming an `h1` element

# Text Decoration

Next we come to `text-decoration`, which is a fascinating property that offers a whole truckload of interesting behaviors.

## **text-decoration**

### Values

`none` | [ `underline` || `overline` || `line-through` || `blink` ] | `inherit`

### Initial value

`none`

### Applies to

All elements

### Inherited

No

### Computed value

As specified

As you might expect, `underline` causes an element to be underlined, just like the `u` element in HTML. `overline` causes the opposite effect—drawing a line across the top of the text. The value `line-through` draws a line straight through the middle of the text, which is also known as *strikethrough text* and is equivalent to the `s` and `strike` elements in HTML. `blink` causes the text to blink on and off, just like the much-maligned `blink` tag supported by Netscape. [Figure 14-30](#) shows examples of each of these values:

```
p.emph {text-decoration: underline;}
```

```
p.topper {text-decoration: overline;}  
p.old {text-decoration: line-through;}  
p.annoy {text-decoration: blink;}  
p.plain {text-decoration: none;}
```

The text of this paragraph, which has a class of 'one', is underlined.

The text of this paragraph, which has a class of 'two', is overlined.

~~The text of this paragraph, which has a class of 'three', is stricken (line-through).~~

The text of this paragraph, which has a class of 'four', is blinking (trust us).

The text of this paragraph, which has a class of 'five', has no decoration of any kind.

**Figure 14-30. Various kinds of text decoration**

**Note**

It's impossible to show the effect of `blink` in print, of course, but it's easy enough to imagine (perhaps all too easy). Incidentally, user agents are not required to actually blink `blink` text, and as of this writing, all known user agents were dropping or had dropped support for the blinking effect. (Internet Explorer never had it.)

The value `none` turns off any decoration that might otherwise have been applied to an element. Usually, undecorated text is the default appearance, but not always. For example, links are usually underlined by default. If you want to suppress the underlining of hyperlinks, you can use the following CSS rule to do so:

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

If you explicitly turn off link underlining with this sort of rule, the only visual difference between the anchors and normal text will be their color (at least by default, though there's no ironclad guarantee that there will be a difference in their colors).

**Note**

Although I personally don't have a problem with it, many users are annoyed when they realize you've turned off link underlining. It's a matter of opinion, so let your own tastes be your guide, but remember: if your link colors aren't sufficiently different from normal text, users may have a hard time finding hyperlinks in your documents, particularly users with one form or another of color blindness.

You can also combine decorations in a single rule. If you want all hyperlinks to be both underlined and overlined, the rule is:

```
a:link, a:visited {text-decoration: underline overline;}
```

Be careful, though: if you have two different decorations matched to the same element, the value of the rule that wins out will completely replace the value of the loser. Consider:

```
h2.stricken {text-decoration: line-through;}  
h2 {text-decoration: underline overline;}
```

Given these rules, any `h2` element with a class of `stricken` will have only a line-through decoration. The underline and overline decorations are lost, since shorthand values replace one another instead of accumulating.

# Weird Decorations

Now, let's look into the unusual side of `text-decoration`. The first oddity is that `text-decoration` is *not* inherited. No inheritance implies that any decoration lines drawn with the text—under, over, or through it—will be the same color as the parent element. This is true even if the descendant elements are a different color, as depicted in [Figure 14-31](#):

```
p {text-decoration: underline; color: black;}  
strong {color: gray;}
```

```
<p>This paragraph, which is black and has a black underline, also  
<strong>strongly emphasized text</strong> which has the black und  
beneath it as well.</p>
```

This paragraph, which is black and has a black underline, also contains  
strongly emphasized text which has the black underline beneath it as well.

**Figure 14-31. Color consistency in underlines**

Why is this so? Because the value of `text-decoration` is not inherited, the `strong` element assumes a default value of `none`. Therefore, the `strong` element has *no* underline. Now, there is very clearly a line under the `strong` element, so it seems silly to say that it has none. Nevertheless, it doesn't. What you see under the `strong` element is the paragraph's underline, which is effectively “spanning” the `strong` element. You can see it more clearly if you alter the styles for the `boldface` element, like this:

```
p {text-decoration: underline; color: black;}  
strong {color: gray; text-decoration: none;}
```

```
<p>This paragraph, which is black and has a black underline, also  
<strong>strongly emphasized text</strong> which has the black und
```

The result is identical to the one shown in [Figure 14-31](#), since all you've done is to explicitly declare what was already the case. In other words, there is no

way to turn off underlining (or overlining or a line-through) generated by a parent element.

When `text-decoration` is combined with `vertical-align`, even stranger things can happen. [Figure 14-32](#) shows one of these oddities. Since the `sup` element has no decoration of its own, but it is elevated within an overlined element, the overline cuts through the `sup` element:

```
p {text-decoration: overline; font-size: 12pt;}  
sup {vertical-align: 50%; font-size: 12pt;}
```

This paragraph, which is black and has a black overline, also contains superscripted text through which the overline will cut.

[Figure 14-32](#). Correct, although strange, decorative behavior

By now you may be vowing never to use text decorations because of all the problems they could create. In fact, I've given you the simplest possible outcomes since we've explored only the way things *should* work according to the specification. In reality, some web browsers do turn off underlining in child elements, even though they aren't supposed to. The reason browsers violate the specification is simple enough: author expectations. Consider this markup:

```
p {text-decoration: underline; color: black;}  
strong {color: silver; text-decoration: none;}  
  
<p>This paragraph, which is black and has a black underline, also  
<strong>boldfaced text</strong> which does not have black underli  
beneath it.</p>
```

[Figure 14-33](#) shows the display in a web browser that has switched off the underlining for the `strong` element.

This paragraph, which is black and has a black underline, also contains strongly emphasized text which should have the black underline beneath it as well.

**Figure 14-33. How some browsers really behave**

The caveat here is that many browsers *do* follow the specification, and future versions of existing browsers (or any other user agents) might one day follow the specification precisely. If you depend on using `none` to suppress decorations, it's important to realize that it may come back to haunt you in the future, or even cause you problems in the present. Then again, future versions of CSS may include the means to turn off decorations without using `none` incorrectly, so maybe there's hope.

There is a way to change the color of a decoration without violating the specification. As you'll recall, setting a text decoration on an element means that the entire element has the same color decoration, even if there are child elements of different colors. To match the decoration color with an element, you must explicitly declare its decoration, as follows:

```
p {text-decoration: underline; color: black;}  
strong {color: silver; text-decoration: underline;}  
  
<p>This paragraph, which is black and has a black underline, also  
<strong>strongly emphasized text</strong> which has the black und  
beneath it as well, but whose gray underline overlays the black u  
of its parent.</p>
```

In [Figure 14-34](#), the `strong` element is set to be gray and to have an underline. The gray underline visually “overwrites” the parent's black underline, so the decoration's color matches the color of the `strong` element.

This paragraph, which is black and has a black underline, also contains  
strongly emphasized text which has the black underline beneath it as well,  
but whose gray underline overlays the black underline of its parent.

**Figure 14-34. Overcoming the default behavior of underlines**

# Text Rendering

A recent addition to CSS is `text-rendering`, which is actually an SVG property that is nevertheless treated as CSS by supporting user agents. It lets authors indicate what the user agent should prioritize when displaying text.

## **text-rendering**

### Values

`auto` | `optimizeSpeed` | `optimizeLegibility` | `geometricPrecision` | `inherit`

### Initial value

`auto`

### Applies to

All elements

### Inherited

Yes

The values `optimizeSpeed` and `optimizeLegibility` are relatively self-explanatory, indicating that drawing speed should be favored over legibility features like kerning and ligatures (for `optimizeSpeed`) or vice versa (for `optimizeLegibility`).

The precise legibility features that are used with `optimizeLegibility` are not explicitly defined, and the text rendering often depends on the operating system on which the user agent is running, so the exact results may vary. [Figure 14-35](#) shows the results of `optimizeLegibility` in various browsers.

# Ten Vipers Infiltrate AWACS

## Ten Vipers Infiltrate AWACS

Figure 14-35. Optimized legibility

As you can see in [Figure 14-35](#), the differences between optimized and non-optimized text are objectively rather small, but they can have a noticeable impact on readability.

The value `geometricPrecision`, on the other hand, directs the user agent to draw the text as precisely as possible, such that it could be scaled up or down with no loss of fidelity. You might think that this is always the case, but not so. Some fonts change kerning or ligature effects at different text sizes, for example, providing more kerning space at smaller sizes and tightening up the kerning space as the size is increased. With `geometricPrecision`, those hints are ignored. If it helps, think of it as the user agent drawing the text as though all the text is a series of SVG paths, not font glyphs.

Even by the usual standards of standards, the value `auto` is pretty vaguely defined in SVG:

...the user agent shall make appropriate tradeoffs to balance speed, legibility and geometric precision, but with legibility given more importance than speed and geometric precision.

That's it: user agents get to do what they think is appropriate, leaning towards legibility. In practice, things are more complicated. As an example, WebKit (as of mid-2013) seems to treat `optimizeLegibility` and `geometricPrecision` as the same, while `auto` is equivalent to `optimizeSpeed`. In the former case, WebKit enables a series of font features in order to increase the legibility; these are disabled for `optimizeSpeed` and `auto`. Gecko, on the other hand, is reported to treat `auto` as `optimizeSpeed` for text sizes at or below 20px, and as `optimizeLegibility` for sizes above 20px.

# Text Shadows

CSS2 introduced a property for adding drop shadows to text. It was dropped from CSS 2.1 due to lack of implementation, but the web has moved on and `text-shadow` is now very widely supported.

## **text-shadow**

### Values

```
none | [<_color> || <length> <length> <length>? ,]* [<color> ||  
<length> <length> <length_>?] | inherit
```

### Initial value

none

### Applies to

All elements

### Inherited

No

The obvious default is to not have a drop shadow for text. Otherwise, it's possible to define one or more shadows. Each shadow is defined by an optional color and three length values, the last of which is also optional.

The color sets the shadow's color, of course, so it's possible to define green, purple, or even white shadows. If the color is omitted, the shadow will be the same color as the text.

The first two length values determine the offset distance of the shadow from the text; the first is the horizontal offset and the second is the vertical offset. To define a solid, un-blurred green shadow offset five pixels to the right and

half an em down from the text, as shown in [Figure 14-36](#), you would write:

```
text-shadow: green 5px 0.5em;
```

Negative lengths cause the shadow to be offset to the left and upward from the original text. The following, also shown in [Figure 14-36](#), places a light blue shadow five pixels to the left and half an em above the text:

```
text-shadow: rgb(128,128,255) -5px -0.5em;
```

Keep your eye on the shadows. They move when you aren't watching.

I run between the shadows—some are phantoms, some are real.

**Figure 14-36. Simple shadows**

The optional third length value defines a “blur radius” for the shadow. The blur radius is defined as the distance from the shadow’s outline to the edge of the blurring effect. A radius of two pixels would result in blurring that fills the space between the shadow’s outline and the edge of the blurring. The exact blurring method is not defined, so different user agents might employ different effects. As an example, the following styles are rendered as shown in [Figure 14-37](#):

```
p.c11 {color: black; text-shadow: gray 2px 2px 4px; }  
p.c12 {color: white; text-shadow: 0 0 4px black; }  
p.c13 {color: black; text-shadow: 1em 0.5em 5px red, -0.5em -1em
```

Keep your eye on the shadows. They move when you aren’t watching.

I run between the shadows—some are phantoms, some are real.

Slipping through the dark streets and the echoes and the shadows...

Slipping through the dark streets and the echoes and the shadows...

**Figure 14-37. Dropping shadows all over**

**Note**

Note that large numbers of text shadows, or text shadows with very large blur values, can create performance slowdowns, particularly in low-power and CPU-constrained situations such as mobile devices. Authors are advised to test thoroughly before deploying public designs that use text shadows.

# Handling White Space

Now that we've covered a variety of ways to style the text, let's talk about the property `white-space`, which affects the user agent's handling of space, newline, and tab characters within the document source.

## **white-space**

### Values

`normal | nowrap | pre | pre-wrap | pre-line | inherit`

### Initial value

`normal`

### Applies to

All elements (CSS 2.1); block-level elements (CSS1 and CSS2)

### Inherited

No

### Computed value

As specified

Using this property, you can affect how a browser treats the white space between words and lines of text. To a certain extent, default XHTML handling already does this: it collapses any white space down to a single space. So given the following markup, the rendering in a web browser would show only one space between each word and ignore the linefeed in the elements:

```
<p>This      paragraph      has      many
```

```
    spaces      in it.</p>
```

You can explicitly set this default behavior with the following declaration:

```
p {white-space: normal;}
```

This rule tells the browser to do as browsers have always done: discard extra white space. Given this value, linefeed characters (carriage returns) are converted into spaces, and any sequence of more than one space in a row is converted to a single space.

Should you set `white-space` to `pre`, however, the white space in an affected element is treated as though the elements were XHTML `pre` elements; white space is *not* ignored, as shown in [Figure 14-38](#):

```
p {white-space: pre;}
```

```
<p>This      paragraph      has      many  
      spaces      in it.</p>
```

This paragraph has many  
spaces in it.

**Figure 14-38. Honoring the spaces in markup**

With a `white-space` value of `pre`, the browser will pay attention to extra spaces and even carriage returns. In this respect, and in this respect alone, any element can be made to act like a `pre` element.

The opposite value is `nowrap`, which prevents text from wrapping within an element, except wherever you use a `br` element. Using `nowrap` in CSS is much like setting a table cell not to wrap in HTML 4 with `<td nowrap>`, except the `white-space` value can be applied to any element. The effects of the following markup are shown in [Figure 14-39](#):

```
<p style="white-space: nowrap;">This paragraph is not allowed to  
which means that the only way to end a line is to insert a line-b  
element. If no such element is inserted, then the line will go f
```

forcing the user to scroll horizontally to read whatever can't be initially displayed <br/> in the browser window.</p>

This paragraph is not allowed to wrap, which means that the only way to end a line is to insert a line-break in the browser window.

**Figure 14-39. Suppressing line wrapping with the white-space property**

You can actually use `white-space` to replace the `nowrap` attribute on table cells:

```
td {white-space: nowrap;}

<table><tr>
<td>The contents of this cell are not wrapped.</td>
<td>Neither are the contents of this cell.</td>
<td>Nor this one, or any after it, or any other cell in this table
<td>CSS prevents any wrapping from happening.</td>
</tr></table>
```

CSS 2.1 introduced the values `pre-wrap` and `pre-line`, which were absent in earlier versions of CSS. The effect of these values is to allow authors to better control white space handling.

If an element is set to `pre-wrap`, then text within that element has white space sequences preserved, but text lines are wrapped normally. With this value, line-breaks in the source and those that are generated are also honored. `pre-line` is the opposite of `pre-wrap` and causes white space sequences to collapse as in normal text but honors new lines. For example, consider the following markup, which is illustrated in [Figure 14-40](#):

```
<p style="white-space: pre-wrap;">
This paragraph has a great many spaces within
content, but their preservation will not prevent
wrapping or line breaking.
</p>
<p style="white-space: pre-line;">
This paragraph has a great many spaces within
content, but their collapse will not prevent line
wrapping or line breaking.
</p>
```

This paragraph has a great many spaces within its textual content, but their preservation will not prevent line wrapping or line breaking.

This paragraph has a great many spaces within its textual content, but their collapse will not prevent line wrapping or line breaking.

**Figure 14-40.** Two different ways to handle white space

[Table 14-1](#) summarizes the behaviors of white-space properties.

Table 14-1. White-space properties

**Value    White space Linefeeds Auto line wrapping**

	pre-line	Collapsed	Honored	Allowed
--	----------	-----------	---------	---------

normal	Collapsed	Ignored	Allowed
--------	-----------	---------	---------

nowrap	Collapsed	Ignored	Prevented
--------	-----------	---------	-----------

pre	Preserved	Honored	Prevented
-----	-----------	---------	-----------

pre-wrap	Preserved	Honored	Allowed
----------	-----------	---------	---------

# Setting Tab Sizes

Since white space is preserved in some values of `white-space`, it stands to reason that tabs (i.e., Unicode code point 0009) will be displayed as, well, tabs. But how many spaces should each tab equal? That's where `tab-size` comes in.

## `tab-size`

### Values

`<_integer>` | `<length_>` | `inherit`

### Initial value

8

### Applies to

Block elements

### Inherited

Yes

### Computed value

The absolute-length equivalent of the specified value

By default, any tab character will be treated the same as eight spaces in a row, but you can alter that by using a different integer value. Thus, `tab-size: 4` will cause each tab to be rendered the same as if it were four spaces in a row.

If a length value is supplied, then each tab is rendered using that length. For example, `tab-size: 10px` will cause a sequence of three tabs to be rendered

as 30 pixels of white space. The effects of the following rules is illustrated in [Figure 14-41](#).

This sentence is preceded by three tabs, set to a length of 8.

This sentence is preceded by three tabs, set to a length of 4.

This sentence is preceded by three tabs, set to a length of 2.

This sentence is preceded by three tabs, set to a length of 0.

This sentence is preceded by three tabs, set to a length of 8—but `white-space` is normal.

**Figure 14-41. Differing tab lengths**

Note that `tab-size` is effectively ignored when the value of `white-space` causes white space to be collapsed (see [Table 14-1](#)). The value will still be computed in such cases, of course, but there will be no visible effect no matter how many tabs appear in the source.

**Note**

Currently, `tab-size` is supported in WebKit and Gecko (as `-moz-tab-size`). In both cases, only integer values are supported, not length values.

# Wrapping and Hyphenation

Hyphens can be very useful in situations where there are long words and short line lengths, such as blog posts on mobile devices and portions of *The Economist*. Authors can always insert their own hyphenation hints using the Unicode character U+00AD SOFT HYPHEN (or, in HTML, &shy;), but CSS also offers a way to enable hyphenation without littering up the document with hints.

## hyphens

### Values

manual | auto | none | inherit

### Initial value

manual

### Applies to

All elements

### Inherited

Yes

### Computed value

As specified

With the default value of `manual`, hyphens are only inserted where there are manually-inserted hyphenation markers in the document, such as U+00AD or &shy;. Otherwise, no hyphenation occurs. The value `none`, on the other hand, suppresses any hyphenation, even if manual break markers are present; thus, U+00AD and &shy; are ignored.

The far more interesting (and potentially inconsistent) value is `auto`, which permits the browser to insert hyphens and break words at “appropriate” places inside words, even where no manually inserted hyphenation breaks exist. This leads to interesting questions like what constitutes a “word” and under what circumstances it is appropriate to hyphenate a word, both of which are highly language-dependent. User agents are supposed to prefer manually inserted hyphen breaks to automatically determined breaks, but there are no guarantees. An illustration of hyphenation, or the suppression thereof, in the following example is shown in [Figure 14-42](#):

```
.c101 {hyphens: auto;}  
.c102 {hyphens: manual;}  
.c103 {hyphens: none;}  
  
<p class="c101">Supercalifragilisticexpialidocious antidisestablishmentarianism.</p>  
<p class="c102">Supercalifragilisticexpialidocious antidisestablishmentarianism.</p>  
<p class="c102">Super-&shy;-cali-&shy;-fragi-&shy;-listic-&shy;-expi-&shy;-anti-&shy;-dis-&shy;-establish-&shy;-ment-&shy;-arian-&shy;-ism.</p>  
<p class="c103">Super-&shy;-cali-&shy;-fragi-&shy;-listic-&shy;-expi-&shy;-anti-&shy;-dis-&shy;-establish-&shy;-ment-&shy;-arian-&shy;-ism.</p>
```

Supercalifragilisticexpialidocious antidisestablishmentarianism.	Supercalifragilisticexpialidocious antidisestablishmentarianism.	Supercalifragilisticexpialidocious antidisestablishmentarianism.
Supercalifragilisticexpialidocious antidisestablishmentarianism.	Supercalifragilisticexpialidocious antidisestablishmentarianism.	Supercalifragilisticexpialidocious antidisestablishmentarianism.
Supercalifragilisticexpialidocious antidisestablishmentarianism.	Supercalifragilisticexpialidocious antidisestablishmentarianism.	Supercalifragilisticexpialidocious antidisestablishmentarianism.
Supercalifragilisticexpialidocious antidisestablishmentarianism.	Supercalifragilisticexpialidocious antidisestablishmentarianism.	Supercalifragilisticexpialidocious antidisestablishmentarianism.

**Figure 14-42. Hyphenation results**

Because hyphenation is so language-dependent, and because the CSS specification does not define precise (or even vague) rules regarding how user agents should carry out hyphenation, there is every chance that hyphenation will be different from one browser to the next.

Furthermore, if you do choose to hyphenate, be careful about the elements to which you apply the hyphenation. `hyphens` is an inherited property, so simply declaring `body {hyphens: auto;}` will apply hyphenation to everything in your document—including `textareas`, code samples, `blockquote`s, and so on. Blocking automatic hyphenation at the level of those elements is probably a good idea, using rules something like this:

```
body {hyphens: auto;}  
code, var, kbd, samp, tt, dir, listing, plaintext, xmp,  
abbr, acronym, blockquote, q, textarea, input, option {hyphens
```

It's probably obvious why suppressing hyphenation in code samples and code blocks is desirable, especially in languages that use hyphens in things like property and value names. (Ahem.) Similar logic holds for keyboard input text—you definitely don't want a stray dash getting into your Unix command line examples! And so on down the line. Of course, if you decide that you want to hyphenate some of these elements, just remove them from the selector. (It can be kind of fun to watch the text you're typing into a `textarea` get auto-hyphenated as you type it.)

**Note**

As of mid-2013, `hyphens` was supported by all major desktop browsers, albeit using vendor prefixes, as well as on many mobile browsers. As noted, such support is always language-dependent.

Hyphens can be suppressed by the effects of other properties, such as `word-break`, which affects how soft wrapping of text is calculated in various languages.

### **word-break**

#### Values

```
normal | break-all | keep-all | inherit
```

#### Initial value

`normal`

Applies to

All elements

Inherited

Yes

Computed value

As specified

When a run of text is too long to fit into a single line, it is “soft wrapped.” This is in contrast to “hard wraps,” which are things like linefeed characters and `<br>` elements. Where the text is soft-wrapped is determined by the user agent (or the OS it uses), but `word-break` lets authors influence its decision-making.

The default value of `normal` means that text should be wrapped like it always has been. In practical terms, this means that text is broken between words, though the definition of a word varies by language. In Latin-derived languages like English, this is almost always a space between letter sequences (e.g., words). In ideographic languages like Japanese, each symbol is a word, so breaks can occur between any two symbols. In other CJK languages, though, the soft-wrap points may be limited to appear between sequences of symbols that are not space-separated.

Again, that’s all by default, and is the way browsers have handled text for years. If you apply the value `break-all`, then soft wrapping can (and will) occur between any two characters, even if they are in the middle of a word. With this value, no hyphens are shown, even if the soft wrapping occurs at a hyphenation point (see `hyphens`, earlier). Note that values of the `line-break` property (described next) can affect the behavior of `break-all` in CJK text.

`keep-all`, on the other hand, suppresses soft wrapping between characters, even in CJK languages where each symbol is a word. Thus, in Japanese, a sequence of symbols with no white space will not be soft wrapped, even if

this means the text line will exceed the length of its element. (This behavior is similar to `white-space: pre`.)

[Figure 14-43](#) shows a few examples of `word-break` values, and [Table 14-2](#) summarizes the effects of each value.



**Figure 14-43. Altering word breaking behavior**

**Table 14-2. Word-breaking behavior**

Value	Non-CJK	CJK	Hyphenation permitted
normal	As usual	As usual	Yes
break-all	After any character	After any character	No
keep-all	As usual	Around sequences	Yes

If your interests run to CJK text, then in addition to `word-break` you will also want to get to know `line-break`.

### **line-break**

#### **Values**

`auto | loose | normal | strict | inherit`

Initial value

`auto`

Applies to

All elements

Inherited

Yes

Computed value

As specified

As we just saw, `word-break` can affect how lines of text are soft-wrapped in CJK text. The `line-break` property also affects such soft wrapping: specifically how wrapping is handled around CJK-specific symbols as well as around non-CJK punctuation (such as exclamation points, hyphens, and ellipses) that appears in text declared to be CJK.

In other words, `line-break` applies to certain CJK characters all the time, regardless of the content's declared language. If you throw some CJK characters into a paragraph of English text, `line-break` will still apply to them, but not to anything else in the text. Conversely, if you declare content to be in a CJK language, `line-break` will continue to apply to those CJK characters *plus* a number of non-CJK characters within the CJK text. These include punctuation marks, currency symbols, and a few other symbols.

There is no authoritative list of which characters are affected and which are not, but [the specification](#) provides a list of recommended symbols and behaviors around those symbols.

The default value `auto` allows user agents to soft wrap text as they like, and more importantly lets UAs vary the line-breaking they do based on the situation. Thus, for example, the UA can use looser line-breaking rules for short lines of text and stricter rules for long lines. In effect, `auto` allows the user agent to switch between the `loose`, `normal`, and `strict` values as

needed, possibly even on a line-by-line basis within a single element.

Doubtless you can infer that those other values have the following general meanings:

`loose`

This value imposes the “least restrictive” rules for wrapping text, and is meant for use when line lengths are short, such as in newspapers.

`normal`

This value imposes the “most common” rules for wrapping text. What exactly “most common” means is not precisely defined, though there is the aforementioned list of recommended behaviors.

`strict`

This value imposes the “most stringent” rules for wrapping text. Again, this is not precisely defined.

# Wrapping Text

After all that information about hyphenation and soft wrapping, what happens when text overflows its container anyway? That's what `overflow-wrap` addresses.

## **overflow-wrap (néé word-wrap)**

Values

`normal` | `break-word` | `inherit`

Initial value

-

Applies to

All elements

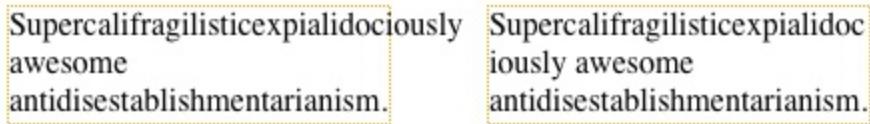
Inherited

Yes

Computed value

-

For once, this property couldn't be more straightforward. If the default value of `normal` is in effect, then wrapping happens as normal (obviously!); which is to say, between words or as directed by the language. If `break-word` is in effect, then wrapping can happen in the middle of words. [Figure 14-44](#) illustrates the difference.



**Figure 14-44. Overflow wrapping**

**Note**

Note that `overflow-wrap` can only operate if the value of `white-space` allows line wrapping. If it does not (e.g., with the value `pre`), then `overflow-wrap` has no effect.

Where `overflow-wrap` gets complicated is in its history and implementation. Once upon a time there was a property called `word-wrap` that did exactly what `overflow-wrap` does. The two are so identical that the specification specifically states that user agents "...must treat `word-wrap` as an alternate name for the `overflow-wrap` property, as if it were a shorthand of `overflow-wrap`."

Of course, browsers don't always do this. As of mid-2013, IE, Firefox, and Safari honored `word-wrap` but not `overflow-wrap`; Blackberry, Opera, and Chrome (and, presumably, Blink) honored both. For this reason, it's actually better to use `word-wrap`, despite it being the vaguely deprecated version. If you want to future-proof, use both:

```
pre {word-wrap: break-word; overflow-wrap: break-word;}
```

While `overflow-wrap: break-word` may appear very similar to `word-break: break-all`, they are not the same thing. To see why, compare the second box in [Figure 14-44](#) to the top middle box in [Figure 14-43](#). As you can see, `overflow-wrap` only kicks in if content actually overflows; thus, when there is an opportunity to use white space in the source to wrap lines, `overflow-wrap` will take it. By contrast, `word-break: break-all` will cause wrapping when content reaches the wrapping edge, regardless of any whitespace that comes earlier in the line.

# Text Direction

If you're reading this book in English or any number of other languages, then you're reading the text left to right and top to bottom, which is the flow direction of English. Not every language runs this way, of course. There are many right-to-left and top-to-bottom languages such as Hebrew and Arabic, and CSS2 introduced a property to describe their directionality.

**direction**

Values

`ltr | rtl | inherit`

Initial value

`ltr`

Applies to

All elements

Inherited

Yes

Computed value

As specified

The `direction` property affects the writing direction of text in a block-level element, the direction of table column layout, the direction in which content horizontally overflows its element box, and the position of the last line of a fully justified element. For inline elements, `direction` applies only if the property `unicode-bidi` is set to either `embed` or `bidi-override`. (See below for a description of `unicode-bidi`.)

## Note

Before CSS3, CSS included no provisions in the specification for top-to-bottom languages. As of this writing, the CSS3 Text Module is a Candidate Recommendation, and it addresses this point with a new property called `writing-mode`, which was poorly supported as of mid-2013.

Although `ltr` is the default, it is expected that if a browser is displaying right-to-left text, the value will be changed to `rtl`. Thus, a browser might carry an internal rule stating something like the following:

```
*:lang(ar), *:lang/he) {direction: rtl;}
```

The real rule would be longer and encompass all right-to-left languages, not just Arabic and Hebrew, but it illustrates the point.

While CSS attempts to address writing direction, Unicode has a much more robust method for handling directionality. With the property `unicode-bidi`, CSS authors can take advantage of some of Unicode's capabilities.

## **unicode-bidi**

### Values

`normal` | `embed` | `bidi-override` | `inherit`

### Initial value

`normal`

### Applies to

All elements

### Inherited

No

### Computed value

## As specified

Here we'll simply quote the value descriptions from the CSS 2.1 specification, which do a good job of capturing the essence of each value:

normal

The element does not open an additional level of embedding with respect to the bidirectional algorithm. For inline-level elements, implicit reordering works across element boundaries.

embed

If the element is inline-level, this value opens an additional level of embedding with respect to the bidirectional algorithm. The direction of this embedding level is given by the `direction` property. Inside the element, reordering is done implicitly. This corresponds to adding an LRE (U+202A; for `direction: ltr`) or an RLE (U+202B; for `direction: rtl`) at the start of the element and a PDF (U+202C) at the end of the element.

bidi-override

This creates an override for inline-level elements. For block-level elements, this creates an override for inline-level descendants not within another block. This means that, inside the element, reordering is strictly in sequence according to the `direction` property; the implicit part of the bidirectional algorithm is ignored. This corresponds to adding an LRO (U+202D; for `direction: ltr`) or RLO (U+202E; for `direction: rtl`) at the start of the element and a PDF (U+202C) at the end of the element.

# Summary

Even without altering the font face, there are many ways to change the appearance of text. There are classic effects such as underlining, of course, but CSS also enables you to draw lines over text or through it, change the amount of space between words and letters, indent the first line of a paragraph (or other block-level element), align text in various ways, exert influence over the hyphenation and line-breaking of text, and much more. You can even alter the amount of space between lines of text. There is also support in CSS for languages other than those that are written left-to-right, top-to-bottom. Given that so much of the Web is text, the strength of these properties makes a great deal of sense. Recent developments in improving text legibility and placement are likely only the beginnings of what we will eventually be able to do with regards to text styling.

# Chapter 15. Selectors

One of the primary advantages of CSS—particularly to designers—is its ability to easily apply a set of styles to all elements of the same type.

Unimpressed? Consider this: by editing a single line of CSS, you can change the colors of all your headings. Don't like the blue you're using? Change that one line of code, and they can all be purple, yellow, maroon, or any other color you desire. That lets you, the designer, focus on design, rather than grunt work. The next time you're in a meeting and someone wants to see headings with a different shade of green, just edit your style and hit Reload.

*Voilà!* The results are accomplished in seconds and there for everyone to see.

Of course, CSS can't solve all your problems—you can't use it to change the colorspace of your PNGs, for example, at least not yet—but it can make some global changes much easier. So let's begin with selectors and structure.

# Basic Style Rules

As stated, a central feature of CSS is its ability to apply certain rules to an entire set of element types in a document. For example, let's say that you want to make the text of all `h2` elements appear gray. Using old-school HTML, you'd have to do this by inserting `<font color="gray">...</font>` tags in all your `h2` elements. Using the `style` attribute, which is also bad practice, would require you to include `style="color: grey;"` in all your `h2` elements:

```
<h2><font color="gray">This is h2 text</font></h2>
<h2 style="color: gray;">This is h2 text</h2>
```

Obviously, this is a tedious process if your document contains a lot of `h2` elements. Worse, if you later decide that you want all those `h2`s to be green instead of gray, you'd have to start the manual tagging all over again. (Yes, this is really how it used to be done!)

CSS allows you to create rules that are simple to change, edit, and apply to all the text elements you define (the next section will explain how these rules work). For example, simply write this rule once to make all your `h2` elements gray:

```
h2 {color: gray;}
```

If you want to change all `h2` text to another color—say, silver—simply alter the value:

```
h2 {color: silver;}
```

# Element Selectors

An element selector is most often an HTML element, but not always. For example, if a CSS file contains styles for an XML document, element selectors might look something like this:

```
quote {color: gray;}  
bib {color: red;}  
booktitle {color: purple;}  
myElement {color: red;}
```

In other words, the elements of the document serve as the most basic selectors. In XML, a selector could be anything, since XML allows for the creation of new markup languages that can have just about anything as an element name. If you're styling an HTML document, on the other hand, the selector will generally be one of the many HTML elements such as `p`, `h3`, `em`, `a`, or even `html` itself. For example:

```
html {color: black;}  
h1 {color: gray;}  
h2 {color: silver;}
```

The results of this style sheet are shown in [Figure 15-1](#).

## Plutonium

Useful for many applications, plutonium can also be dangerous if improperly handled.

### Safety Information

When handling plutonium, care must be taken to avoid the formation of a critical mass.

With plutonium, the possibility of implosion is very real, and must be avoided at all costs. This can be accomplished by keeping the various masses separate.

### Comments

It's best to avoid using plutonium **at all** if it can be avoided.

**Figure 15-1.** Simple styling of a simple document

Once you've globally applied styles directly to elements, you can shift those styles from one element to another. Let's say you decide that the paragraph text, not the `h1` elements, in [Figure 15-1](#) should be gray. No problem. Simply change the `h1` selector to `p`:

```
html {color: black;}  
p {color: gray;}  
h2 {color: silver;}
```

The results are shown in [Figure 15-2](#).

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**Figure 15-2.** Moving a style from one element to another

# Declarations and Keywords

The declaration block contains one or more declarations. A declaration is always formatted as a *property* followed by a colon and then a *value* followed by a semicolon. The colon and semicolon can be followed by zero or more spaces. In nearly all cases, a value is either a single keyword or a space-separated list of one or more keywords that are permitted for that property. If you use an incorrect property or value in a declaration, the whole rule will be ignored. Thus, the following two declarations would fail:

```
brain-size: 2cm; /* unknown property 'brain-size' */  
color: ultraviolet; /* unknown value 'ultraviolet' */
```

In an instance where you can use more than one keyword for a property's value, the keywords are usually separated by spaces, with some cases requiring slashes (/) or commas. Not every property can accept multiple keywords, but many, such as the `font` property, can. Let's say you want to define medium-sized Helvetica for paragraph text, as illustrated in [Figure 15-3](#).

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**Figure 15-3.** The results of a property value with multiple keywords

The rule would read as follows:

```
p {font: medium Helvetica;}
```

Note the space between `medium` and `Helvetica`, each of which is a keyword (the first is the font's size and the second is the actual font name). The space allows the user agent to distinguish between the two keywords and apply them correctly. The semicolon indicates that the declaration has been concluded.

These space-separated words are referred to as keywords because, taken together, they form the value of the property in question. For instance, consider the following fictional rule:

```
rainbow: red orange yellow green blue indigo violet;
```

There is no such property as `rainbow`, of course, but the example is useful for illustrative purposes. The value of `rainbow` is `red orange yellow green blue indigo violet`, and the seven keywords add up to a single, unique value. We can redefine the value for `rainbow` as follows:

```
rainbow: infrared red orange yellow green blue indigo violet ultr
```

Now we have a new value for `rainbow` composed of nine keywords instead of seven. Although the two values look mostly the same, they are as unique and different as zero and one. This may seem an abstract point, but it's critical to understanding some of the subtler effects of specificity and the cascade (covered in later in this book).

As we've seen, CSS keywords are usually separated by spaces—with a few exceptions in one instance.

In CSS2.1 there was one exception: in the CSS property `font`, there is exactly one place where a forward slash (/) could be used to separate two specific keywords. Here's an example:

```
h2 {font: large/150% sans-serif;}
```

The slash separates the keywords that set the element's font size and line

height. This is the only place the slash is allowed to appear in the `font` declaration. All of the other keywords allowed for `font` are separated by spaces.

The slash also makes an appearance in the CSS border-radius shorthand property between the vertical and horizontal declarations.

```
div {border-radius: 1em / 2em; }
```

There are also some keywords that are separated by commas. When declaring multiple values, such as multiple background images, transition properties and shadows, the declarations are separated with commas. Additionally, parameters in functions, such as linear gradients and transforms, are comma separated.

```
.box {box-shadow: inset -1px -1px white,
          3px 3px 3px rgba(0,0,0,0.2);
      background-image: url(myimage.png),
          linear-gradient(180deg, #FFF 0%, #000 100%);
      transform: translate(100px, 200px);
}
a:hover {transition: color, background-color 200ms ease-in 50ms;}
```

Those are the basics of simple declarations, but they can get much more complex. The next section begins to show you just how powerful CSS can be.

# Grouping

So far, we've seen fairly simple techniques for applying a single style to a single selector. But what if you want the same style to apply to multiple elements? If that's the case, you'll want to use more than one selector or apply more than one style to an element or group of elements.

# Grouping Selectors

Let's say you want both `h2` elements and paragraphs to have gray text. The easiest way to accomplish this is to use the following declaration:

```
h2, p {color: gray;}
```

By placing the `h2` and `p` selectors on the left side of the rule and separating them with a comma, you've defined a rule where the style on the right (`color: gray;`) applies to the elements referenced by both selectors. The comma tells the browser that there are two different selectors involved in the rule. Leaving out the comma would give the rule a completely different meaning, which we'll explore later in "["Descendant Selectors"](#)".

There are really no limits to how many selectors you can group together. For example, if you want to display a large number of elements in gray, you might use something like the following rule:

```
body, table, th, td, h1, h2, h3, h4, p, pre, strong, em, b, i {co
```

Grouping allows an author to drastically compact certain types of style assignments, which makes for a shorter style sheet. The following alternatives produce exactly the same result, but it's pretty obvious which one is easier to type:

```
h1 {color: purple;}  
h2 {color: purple;}  
h3 {color: purple;}  
h4 {color: purple;}  
h5 {color: purple;}  
h6 {color: purple;}  
  
h1, h2, h3, h4, h5, h6 {color: purple;}
```

Grouping allows for some interesting choices. For example, all of the groups of rules in the following example are equivalent—each merely shows a different way of grouping both selectors and declarations:

```
/* group 1 */
h1 {color: silver; background: white;}
h2 {color: silver; background: gray;}
h3 {color: white; background: gray;}
h4 {color: silver; background: white;}
b {color: gray; background: white;}

/* group 2 */
h1, h2, h4 {color: silver;}
h2, h3 {background: gray;}
h1, h4, b {background: white;}
h3 {color: white;}
b {color: gray;}

/* group 3 */
h1, h4 {color: silver; background: white;}
h2 {color: silver;}
h3 {color: white;}
h2, h3 {background: gray;}
b {color: gray; background: white;}
```

Any of these will yield the result shown in [Figure 15-4](#). (These styles use grouped declarations, which are explained in an upcoming section, [“Grouping Declarations”](#).)

## Plutonium

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### Safety Information

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### Comments

It's best to avoid using plutonium **at all** if it can be avoided.

**Figure 15-4.** The result of equivalent style sheets

## The universal selector

CSS2 introduced a new simple selector called the *universal selector*, displayed as an asterisk (\*). This selector matches any element at all, much like a wildcard. For example, to make every single element in a document red, you would write:

```
* {color: red;}
```

This declaration is equivalent to a grouped selector that lists every single element contained within the document. The universal selector lets you assign the `color` value `red` to every element in the document in one efficient stroke. Beware, however: although the universal selector is convenient, with a specificity on 0-0-0, and by nature of the fact that it targets everything within its declaration scope, it can have unintended consequences, which are discussed later in this book.

# Grouping Declarations

Since you can group selectors together into a single rule, it follows that you can also group declarations. Assuming that you want all `h1` elements to appear in purple, 18-pixel-high Helvetica text on an aqua background (and you don't mind blinding your readers), you could write your styles like this:

```
h1 {font: 18px Helvetica;}  
h1 {color: purple;}  
h1 {background: aqua;}
```

But this method is inefficient—imagine creating such a list for an element that will carry 10 or 15 styles! Instead, you can group your declarations together:

```
h1 {font: 18px Helvetica; color: purple; background: aqua;}
```

This will have exactly the same effect as the three-line style sheet just shown.

Note that using semicolons at the end of each declaration is crucial when you're grouping them. Browsers ignore whitespace in style sheets, so the user agent must rely on correct syntax to parse the style sheet. You can fearlessly format styles like the following:

```
h1 {  
    font: 18px Helvetica;  
    color: purple;  
    background: aqua;  
}
```

You can also minimize your CSS, removing all non-required spaces.

```
h1{font:18px Helvetica;color:purple;background:aqua;}
```

Ignoring whitespace, the above three are treated equally by the server, but the second one is most human readable, and the recommended method of marking up your CSS during development.

If the semicolon is omitted on the second statement, the user agent will interpret the style sheet as follows:

```
h1 {  
    font: 18px Helvetica;  
    color: purple background: aqua;  
}
```

Because `background:` is not a valid value for `color`, and because `color` can be given only one keyword, a user agent will ignore the `color` declaration (including the `background: aqua` part) entirely. You might think the browser would at least render `h1`s as purple text without an aqua background, but not so. Instead, they will be the default color (which is usually black) with a transparent background (which is also a default). The declaration `font: 18px Helvetica` will still take effect since it was correctly terminated with a semicolon.

#### Note

Although it is not technically necessary to follow the last declaration of a rule with a semicolon in CSS, it is generally good practice to do so. First, it will keep you in the habit of terminating your declarations with semicolons, the lack of which is one of the most common causes of rendering errors. Second, if you decide to add another declaration to a rule, you won't have to worry about forgetting to insert an extra semicolon. Third, if you ever use a preprocessor like Sass, trailing semicolons are often required for all declarations. Avoid all these problems—always follow a declaration with a semicolon, wherever the rule appears.

As with selector grouping, declaration grouping is a convenient way to keep your style sheets short, expressive, and easy to maintain.

# Grouping Everything

You now know that you can group selectors and you can group declarations. By combining both kinds of grouping in single rules, you can define very complex styles using only a few statements. Now, what if you want to assign some complex styles to all the headings in a document, and you want the same styles to be applied to all of them? Here's how to do it:

```
h1, h2, h3, h4, h5, h6 {color: gray; background: white; padding:  
border: 1px solid black; font-family: Charcoal, sans-serif;}
```

You've grouped the selectors, so the styles on the right side of the rule will be applied to all the headings listed; grouping the declarations means that all of the listed styles will be applied to the selectors on the left side of the rule. The result of this rule is shown in [Figure 15-5](#).

## Plutonium

Useful for many applications, plutonium can also be dangerous if improperly handled.

## Safety Information

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With plutonium, the possibility of implosion is very real, and must be avoided at all costs. This can be accomplished by keeping the various masses separate.

## Comments

It's best to avoid using plutonium **at all** if it can be avoided.

**Figure 15-5.** Grouping both selectors and rules

This approach is preferable to the drawn-out alternative, which would begin with something like this:

```
h1 {color: gray;}  
h2 {color: gray;}  
h3 {color: gray;}  
h4 {color: gray;}  
h5 {color: gray;}  
h6 {color: gray;}  
h1 {background: white;}  
h2 {background: white;}  
h3 {background: white;}
```

...and continue for many lines. You *can* write out your styles the long way, but I wouldn't recommend it—editing them would be as tedious as using `style` attributes everywhere!

It's possible to add even more expression to selectors and to apply styles in a way that cuts across elements in favor of types of information. Of course, to get something so powerful, you'll have to do a little work in return, but it's well worth it.

With updates to HTML, like the HTML5 specification, new elements have come about. Some browsers predate and don't support some of these newer elements. Versions of Internet Explorer prior to IE9, did not support selecting elements they did not understand when using element selectors based on elements they did not recognize. The solution was to create the element in the DOM, thereby informing the browser that said element may exist. For example, IE8 does not recognize the `<main>` element.

```
document.createElement('main');
```

By creating the element with `createElement`, older versions of Internet Explorer will recognize the existence of the element, allowing it to be selected and styled.

# Class and ID Selectors

So far, we've been grouping selectors and declarations together in a variety of ways, but the selectors we've been using are very simple ones that refer only to document elements. Element selectors are fine up to a point, but there are times when you need something a little more specialized.

In addition to raw document elements, there are *class selectors* and *ID selectors*, which let you assign styles in a way that is independent of document elements. These selectors can be used on their own or in conjunction with element selectors. However, they work only if you've marked up your document appropriately, so using them generally involves a little forethought and planning.

For example, say you're drafting a document that discusses ways of handling plutonium. The document contains various warnings about safely dealing with such a dangerous substance. You want each warning to appear in boldface text so that it will stand out. However, you don't know which elements these warnings will be. Some warnings could be entire paragraphs, while others could be a single item within a lengthy list or a small section of text. So, you can't define a rule using element selectors of any kind. Suppose you tried this route:

```
p {  
    font-weight: bold;  
    color: red;  
}
```

*All* paragraphs would be red and bold, not just those that contain warnings. You need a way to select only the text that contains warnings, or more precisely, a way to select only those elements that are warnings. How do you do it? You apply styles to parts of the document that have been marked in a certain way, independent of the elements involved, by using class selectors.

# Class Selectors

The most common way to apply styles without worrying about the elements involved is to use class selectors. Before you can use them, however, you need to modify your actual document markup so that the class selectors will work. Enter the `class` attribute:

```
<p class="warning">When handling plutonium, care must be taken to  
the formation of a critical mass.</p>  
<p>With plutonium, <span class="warning">the possibility of implo  
very real, and must be avoided at all costs</span>. This can be a  
by keeping the various masses separate.</p>
```

To associate the styles of a class selector with an element, you must assign a `class` attribute to the appropriate value. In the previous code, a class value of `warning` was assigned to two elements: the first paragraph and the `span` element in the second paragraph.

All you need now is a way to apply styles to these classed elements. In HTML documents, you can use a very compact notation where the name of a `class` is preceded by a period (.) and can be joined with an element selector:

```
.warning {font-weight: bold;}
```

When combined with the example markup shown earlier, this simple rule has the effect shown in [Figure 15-6](#). That is, the declaration `font-weight: bold` will be applied to every element (thanks to the presence of the implicit universal selector) that carries a `class` attribute with a value of `warning`.

## Note

==== The universal selector, represented by \*, is implied when an ID, class, attribute selector, pseudo-class or pseudo-element selector is written without being attached to an element selector. ===

# Plutonium

Useful for many applications, plutonium can also be dangerous if improperly handled.

## Safety Information

**When handling plutonium, care must be taken to avoid the formation of a critical mass.**

With plutonium, **the possibility of implosion is very real, and must be avoided at all costs.** This can be accomplished by keeping the various masses separate.

## Comments

It's best to avoid using plutonium **at all** if it can be avoided.

**Figure 15-6. Using a class selector**

As you can see, the class selector works by directly referencing a value that will be found in the `class` attribute of an element. This reference is *always* preceded by a period (.), which marks it as a class selector. The period helps keep the class selector separate from anything with which it might be combined—such as an element selector. For example, you may want boldface text only when an entire paragraph is a warning:

```
p.warning {font-weight: bold;}
```

The selector now matches any `p` elements that have a `class` attribute containing the word `warning`, but no other elements of any kind, classed or otherwise. Since the `span` element is not a paragraph, the rule's selector doesn't match it, and it won't be displayed using boldfaced text.

If you did want to assign different styles to the `span` element, you could use the selector `span.warning`:

```
p.warning {font-weight: bold;}  
span.warning {font-style: italic;}
```

In this case, the warning paragraph is boldfaced, while the warning `span` is italicized. Each rule applies only to a specific type of element/class

combination, so it does not leak over to other elements.

Another option is to use a combination of a general class selector and an element-specific class selector to make the styles even more useful, as in the following markup:

```
.warning {font-style: italic;}  
span.warning {font-weight: bold;}
```

The results are shown in [Figure 15-7](#).

## Plutonium

Useful for many applications, plutonium can also be dangerous if improperly handled.

### Safety Information

*When handling plutonium, care must be taken to avoid the formation of a critical mass.*

With plutonium, ***the possibility of implosion is very real, and must be avoided at all costs.*** This can be accomplished by keeping the various masses separate.

### Comments

It's best to avoid using plutonium **at all** if it can be avoided.

**Figure 15-7.** Using generic and specific selectors to combine styles

In this situation, any warning text will be italicized, but only the text within a `span` element with a `class` of `warning` will be both boldfaced and italicized.

Notice the format of the general class selector in the previous example: it's simply a class name preceded by a period without any element name, and no universal selector. In cases where you only want to select all elements that share a class name, you can omit the universal selector from a class selector without any ill effects.

# Multiple Classes

In the previous section, we dealt with `class` values that contained a single word. In HTML, it's possible to have a space-separated list of words in a single `class` value. For example, if you want to mark a particular element as being both urgent and a warning, you could write:

```
<p class="urgent warning">When handling plutonium, care must be t  
avoid the formation of a critical mass.</p>  
<p>With plutonium, <span class="warning">the possibility of implo  
very real, and must be avoided at all costs</span>. This can be a  
by keeping the various masses separate.</p>
```

The order of the words doesn't actually matter; `warning urgent` would also suffice and would yield precisely the same results no matter how the CSS `class` attribute is written.

Now let's say you want all elements with a `class` of `warning` to be boldfaced, those with a `class` of `urgent` to be italic, and those elements with both values to have a silver background. This would be written as follows:

```
.warning {font-weight: bold;}  
.urgent {font-style: italic;}  
.warning.urgent {background: silver;}
```

By chaining two class selectors together, you can select only those elements that have both class names, in any order. As you can see, the HTML source contains `class="urgent warning"` but the CSS selector is written `.warning.urgent`. Regardless, the rule will still cause the “When handling plutonium . . .” paragraph to have a silver background, as illustrated in [Figure 15-8](#). This happens because the order the words are written in doesn't matter. (This is not to say the order of classes is always irrelevant, but we'll get to that later in the book.)

# Plutonium

Useful for many applications, plutonium can also be dangerous if improperly handled.

## Safety Information

***When handling plutonium, care must be taken to avoid the formation of a critical mass.***

With plutonium, **the possibility of implosion is very real, and must be avoided at all costs.** This can be accomplished by keeping the various masses separate.

## Comments

It's best to avoid using plutonium **at all** if it can be avoided.

**Figure 15-8. Selecting elements with multiple class names**

If a multiple class selector contains a name that is not in the space-separated list, then the match will fail. Consider the following rule:

```
p.warning.help {background: red;}
```

As you would expect, the selector will match only those `p` elements with a class containing the words `warning` and `help`. Therefore, it will not match a `p` element with just the words `warning` and `urgent` in its `class` attribute. It would, however, match the following:

```
<p class="urgent warning help">Help me!</p>
```

# ID Selectors

In some ways, ID selectors are similar to class selectors, but there are a few crucial differences. First, ID selectors are preceded by an octothorpe (#)—also known as a pound sign (in the US), hash sigh,hash mark, or tic-tac-toe board—instead of a period. Thus, you might see a rule like this one:

```
*#first-para {font-weight: bold;}
```

This rule produces boldfaced text in any element whose `id` attribute has a value of `first-para`.

The second difference is that instead of referencing values of the `class` attribute, ID selectors refer, unsurprisingly, to values found in `id` attributes. Here's an example of an ID selector in action:

```
*#lead-para {font-weight: bold;}  
  
<p id="lead-para">This paragraph will be boldfaced.</p>  
<p>This paragraph will NOT be bold.</p>
```

Note that the value `lead-para` could have been assigned to any element within the document. In this particular case, it is applied to the first paragraph, but you could have applied it just as easily to the second or third paragraph.

As with class selectors, it is possible to omit the universal selector from an ID selector. In the previous example, you could also have written:

```
#lead-para {font-weight: bold;}
```

The effect of this selector would be the same.

Another similarity between classes and IDs is that IDs can also be selected independently of an element. There may be circumstances in which you know that a certain ID value will appear in a document, but you don't know the element on which it will appear (as in the plutonium-handling warnings),

so you'll want to declare standalone ID selectors. For example, you may know that in any given document, there will be an element with an ID value of `mostImportant`. You don't know whether that most important thing will be a paragraph, a short phrase, a list item, or a section heading. You know only that it will exist in each document, occur in an arbitrary element, and appear no more than once. In that case, you would write a rule like this:

```
#mostImportant {color: red; background: yellow;}
```

This rule would match any of the following elements (which, as noted before, should *not* appear together in the same document because they all have the same ID value):

```
<h1 id="mostImportant">This is important!</h1>
<em id="mostImportant">This is important!</em>
<ul id="mostImportant">This is important!</ul>
```

While ids are limited to a single occurrence per document, if the above were erroneously included in a single document, all three would have red text with a yellow background. Repeating the same id value within a page will create invalid code, and may cause broken JavaScript functionality, browsers will still style all matched elements.

# Deciding Between Class and ID

You may assign classes to any number of elements, as demonstrated earlier; the class name warning was applied to both a `p` and a `span` element, and it could have been applied to many more elements. IDs, on the other hand, are used once, and only once, within an HTML document. Therefore, if you have an element with an `id` value of `lead-para`, no other element in that document can have an `id` value of `lead-para`.

## Note

In the real world, browsers don't always check for the uniqueness of IDs in HTML. That means that if you sprinkle an HTML document with several elements, all of which have the same value for their ID attributes, you'll probably get the same styles applied to each. This is incorrect behavior, but it happens anyway. Having more than one of the same ID value in a document also makes DOM scripting more difficult, since functions like `getElementById()` depend on there being one, and only one, element with a given ID value.

Unlike class selectors, ID selectors can't be combined with other IDs, since ID attributes do not permit a space-separated list of words.

Another difference between `class` and `id` names is that IDs carry more weight when you're trying to determine which styles should be applied to a given element. This will be explained in greater detail later on.

Also note that class and ID selectors may be case-sensitive, depending on the document language. HTML defines class and ID values to be case-sensitive, so the capitalization of your class and ID values must match that found in your documents. Thus, in the following pairing of CSS and HTML, the elements text will not be boldfaced:

```
p.criticalInfo {font-weight: bold;}  
<p class="criticalinfo">Don't look down.</p>
```

Because of the change in case for the letter *i*, the selector will not match the element shown.

On a purely syntactical level, the dot-class notation (e.g., `.warning`) is not guaranteed to work for XML documents. As of this writing, the dot-class notation works in HTML, SVG, and MathML, and it may well be permitted in future languages, but it's up to each language's specification to decide that. The hash-ID notation (e.g., `#lead`) will work in any document language that has an attribute that enforces uniqueness within a document. Uniqueness can be enforced with an attribute called `id`, or indeed anything else, as long as the attribute's contents are defined to be unique within the document.

# Attribute Selectors

When it comes to both class and ID selectors, what you're really doing is selecting values of attributes. The syntax used in the previous two sections is particular to HTML, XHTML, SVG, and MathML documents (as of this writing). In other markup languages, these class and ID selectors may not be available (as, indeed, those attributes may not be present). To address this situation, CSS2 introduced *attribute selectors*, which can be used to select elements based on their attributes and the values of those attributes. There are four general types of attribute selectors: simple attribute selectors, exact attribute value selectors, partial-match attribute value selectors, and leading-value attribute selectors.

# Simple Attribute Selectors

If you want to select elements that have a certain attribute, regardless of that attribute's value, you can use a simple attribute selector. For example, to select all `h1` elements that have a `class` attribute with any value and make their text silver, write:

```
h1[class] {color: silver;}
```

So, given the following markup:

```
<h1 class="hoopla">Hello</h1>
<h1>Serenity</h1>
<h1 class="fancy">Fooling</h1>
```

...you get the result shown in [Figure 15-9](#).



The figure shows a screenshot of a web browser displaying three `h1` elements. The first element, "Hello", is displayed in a light gray font. The second element, "Serenity", is displayed in a dark gray font. The third element, "Fooling", is displayed in a light gray font. This visual representation corresponds to the CSS rule where the first and third `h1` elements have the `class` attribute and thus inherit the `color: silver;` style, while the second `h1` element does not have the `class` attribute and thus retains the default black font color.

**Figure 15-9.** Selecting elements based on their attributes

This strategy is very useful in XML documents, as XML languages tend to have element and attribute names that are very specific to their purpose. Consider an XML language that is used to describe planets of the solar system (we'll call it PlanetML). If you want to select all `pml-planet` elements with a `moons` attribute and make them boldface, thus calling attention to any planet that has moons, you would write:

```
pml-planet[moons] {font-weight: bold;}
```

This would cause the text of the second and third elements in the following

markup fragment to be boldfaced, but not the first:

```
<pml-planet>Venus</pml-planet>
<pml-planet moons="1">Earth</pml-planet>
<pml-planet moons="2">Mars</pml-planet>
```

In HTML documents, you can use this feature in a number of creative ways. For example, you could style all images that have an `alt` attribute, thus highlighting those images that are correctly formed:

```
img[alt] {border: 3px solid red;}
```

(This particular example is generally useful more for diagnostic purposes—that is, determining whether images are indeed correctly marked up—than for design purposes.)

If you wanted to boldface any element that includes `title` information, which most browsers display as a “tool tip” when a cursor hovers over the element, you could write:

```
*[title] {font-weight: bold;}
```

Similarly, you could style only those anchors (`a` elements) that have an `href` attribute, thus applying the styles to any hyperlink but not to any placeholder anchors.

It is also possible to select based on the presence of more than one attribute. You do this simply by chaining the attribute selectors together. For example, to boldface the text of any HTML hyperlink that has both an `href` and a `title` attribute, you would write:

```
a[href][title] {font-weight: bold;}
```

This would boldface the first link in the following markup, but not the second or third:

```
<a href="http://www.w3.org/" title="W3C Home">W3C</a><br />
<a href="http://www.webstandards.org">Standards Info</a><br />
<a title="Not a link">dead.letter</a>
```

# Selection Based on Exact Attribute Value

You can further narrow the selection process to encompass only those elements whose attributes are a certain value. For example, let's say you want to boldface any hyperlink that points to a certain document on the web server. This would look something like:

```
a[href="http://www.css-discuss.org/about.html"] {font-weight: bol
```

This will boldface the text of any `a` element that has an `href` attribute with *exactly* the value <http://www.css-discuss.org/about.html>. Any change at all, even dropping the `www.` part or changing to a secure protocol with `https`, will prevent a match.

Any attribute and value combination can be specified for any element. However, if that exact combination does not appear in the document, then the selector won't match anything. Again, XML languages can benefit from this approach to styling. Let's return to our PlanetML example. Suppose you want to select only those `planet` elements that have a value of `1` for the attribute `moons`:

```
planet[moons="1"] {font-weight: bold;}
```

This would boldface the text of the second element in the following markup fragment, but not the first or third:

```
<planet>Venus</planet>
<planet moons="1">Earth</planet>
<planet moons="2">Mars</planet>
```

As with attribute selection, you can chain together multiple attribute-value selectors to select a single document. For example, to double the size of the text of any HTML hyperlink that has both an `href` with a value of <http://www.w3.org/> and a `title` attribute with a value of `W3C Home`, you would write:

```
a[href="http://www.w3.org/"] [title="W3C Home"] {font-size: 200%;}
```

This would double the text size of the first link in the following markup, but not the second or third:

```
<a href="http://www.w3.org/" title="W3C Home">W3C</a><br />
<a href="http://www.webstandards.org"
    title="Web Standards Organization">Standards Info</a><br />
<a href="http://www.example.org/" title="W3C Home">dead.link</a>
```

The results are shown in [Figure 15-10](#).



**Figure 15-10.** Selecting elements based on attributes and their values

Again, this format requires an *exact* match for the attribute's value. Matching becomes an issue when the selector form encounters values that can in turn contain a space-separated list of values (e.g., the HTML attribute `class`). For example, consider the following markup fragment:

```
<planet type="barren rocky">Mercury</planet>
```

The only way to match this element based on its exact attribute value is to write:

```
planet[type="barren rocky"] {font-weight: bold;}
```

If you were to write `planet[type="barren"]`, the rule would not match the example markup and thus would fail. This is true even for the `class` attribute in HTML. Consider the following:

```
<p class="urgent warning">When handling plutonium, care must be t
avoid the formation of a critical mass.</p>
```

To select this element based on its exact attribute value, you would have to write:

```
p[class="urgent warning"] {font-weight: bold;}
```

This is *not* equivalent to the dot-class notation covered earlier, as we will see in the next section. Instead, it selects any `p` element whose `class` attribute has *exactly* the value "urgent warning", with the words in that order and a single space between them. It's effectively an exact string match.

Also, be aware that ID selectors and attribute selectors that target the `id` attribute are not precisely the same. In other words, there is a subtle but crucial difference between `h1#page-title` and `h1[id="page-title"]`. This difference is explained in the next chapter in the section on specificity.

# Selection Based on Partial Attribute Values

Odds are that you'll want to select elements based on portions of their attribute values, rather than the full value. For such situations, CSS actually offers a variety of options for matching substrings in an attribute's value. These are summarized in [Table 15-1](#).

Table 15-1. Substring matching with attribute selectors

Type	Description
<code>[foo~="bar"]</code>	Selects any element with an attribute <code>foo</code> whose value contains the word <code>bar</code> in a space-separated list of words.
<code>[foo*="bar"]</code>	Selects any element with an attribute <code>foo</code> whose value <i>contains</i> the substring <code>bar</code> .
<code>[foo^="bar"]</code>	Selects any element with an attribute <code>foo</code> whose value <i>begins</i> with <code>bar</code> .
<code>[foo\$="bar"]</code>	Selects any element with an attribute <code>foo</code> whose value <i>ends</i> with <code>bar</code> .
<code>[foo = "bar"]</code>	Selects any element with an attribute <code>foo</code> whose value <i>starts</i> with <code>bar</code> followed by a dash (U+002D) or whose value is exactly equal to <code>bar</code> .

# A Particular Attribute Selection Type

The first of these attribute selectors that match on a partial subset of an element's attribute value is actually easier to show than it is to describe. Consider the following rule:

```
*[lang|="en"] {color: white;}
```

This rule will select any element whose `lang` attribute is equal to `en` or begins with `en-`. Therefore, the first three elements in the following example markup would be selected, but the last two would not:

```
<h1 lang="en">Hello!</h1>
<p lang="en-us">Greetings!</p>
<div lang="en-au">G'day!</div>
<p lang="fr">Bonjour!</p>
<h4 lang="cy-en">Jrooana!</h4>
```

In general, the form `[att|= "val"]` can be used for any attribute and its values. Let's say you have a series of figures in an HTML document, each of which has a filename like `figure-1.gif` and `figure-3.jpg`. You can match all of these images using the following selector:

```
img[src|="figure"] {border: 1px solid gray;}
```

Or, if you're creating a CSS framework or pattern library, instead of creating redundant classes like "`btn btn-small btn-arrow btn-active`" you can declare "`btn-small-arrow-active`", and targeting the class of elements with

```
*[class|="btn"] { border-radius: 5px; }

<button class="btn-small-arrow-active">Click Me</button>
```

The most common use for this type of attribute selector is to match language values, as demonstrated later in this chapter.

## Matching one word in a space-separated list

For any attribute that accepts a space-separated list of words, it is possible to select elements based on the presence of any one of those words. The classic example in HTML is the `class` attribute, which can accept one or more words as its value. Consider our usual example text:

```
<p class="urgent warning">When handling plutonium, care must be taken  
to avoid the formation of a critical mass.</p>
```

Let's say you want to select elements whose `class` attribute contains the word `warning`. You can do this with an attribute selector:

```
p[class~="warning"] {font-weight: bold;}
```

Note the presence of the tilde (~) in the selector. It is the key to selection based on the presence of a space-separated word within the attribute's value. If you omit the tilde, you would have an exact value matching attribute selector, as discussed in the previous section.

This selector construct is equivalent to the dot-class notation discussed earlier in the chapter. Thus, `p.warning` and `p[class~="warning"]` are equivalent when applied to HTML documents. Here's an example that is an HTML version of the "PlanetML" markup seen earlier:

```
<span class="barren rocky">Mercury</span>  
<span class="cloudy barren">Venus</span>  
<span class="life-bearing cloudy">Earth</span>
```

To italicize all elements with the word `barren` in their `class` attribute, you write:

```
span[class~="barren"] {font-style: italic;}
```

This rule's selector will match the first two elements in the example markup and thus italicize their text, as shown in [Figure 15-11](#). This is the same result we would expect from writing `span.barren {font-style: italic;}`.

*Mercury Venus Earth*

**Figure 15-11.** Selecting elements based on portions of attribute values

So why bother with the tilde-equals attribute selector in HTML? Because it can be used for any attribute, not just `class`. For example, you might have a document that contains a number of images, only some of which are figures. You can use a partial-match value attribute selector aimed at the `title` text to select only those figures:

```
img[title~="Figure"] {border: 1px solid gray;}
```

This rule will select any image whose `title` text contains the word `Figure`. Therefore, as long as all your figures have `title` text that looks something like “Figure 4. A bald-headed elder statesman,” this rule will match those images. For that matter, the selector `img[title~="Figure"]` will also match a title attribute with the value “How to Figure Out Who’s in Charge.” Any image that does not have a `title` attribute, or whose `title` value doesn’t contain the word “Figure,” won’t be matched.

## Matching a substring within an attribute value

Sometimes you want to select elements based on a portion of their attribute values, but the values in question aren’t space-separated lists of words. In these cases, you can use the form `[att*="val"]` to match substrings that appear anywhere inside the attribute values. For example, the following CSS matches any `span` element whose `class` attribute contains the substring `cloud`, so both “cloudy” planets are matched, as shown in [Figure 15-12](#).

```
span[class*="cloud"] {font-style: italic;}  
  
<span class="barren rocky">Mercury</span>  
<span class="cloudy barren">Venus</span>  
<span class="life-bearing cloudy">Earth</span>
```

*Mercury Venus Earth*

**Figure 15-12.** Selecting elements based on substrings within attribute values

As you can imagine, there are many useful applications for this particular capability. For example, suppose you wanted to specially style any links to the O’Reilly Media website. Instead of classing them all and writing styles

based on that class, you could simply write the following rule:

```
a[href*="oreilly.com"] {font-weight: bold;}
```

Of course, you aren't confined to the `class` and `href` attributes. Any attribute is up for grabs here. `title`, `alt`, `src`, `id`... you name it, you can style based on a substring within an attribute's value. The following rule draws attention to any image with the string "space" in its source URL:

```
img[src*="space"] {border: 5px solid red;}
```

You aren't confined to the `class` and `href` attributes. Any attribute is up for grabs here. `title`, `alt`, `src`, `id`... you name it, you can style based on a substring within an attribute's value. The following rule draws attention to input elements that have a title tells the user what to, and any other input whose title contains the substring "format" in its title:

```
input[title*="format"] {background-color: #dedede; }

<input type="tel"
      title="Telephone number should be formatted as XXX-XXX-XXXX"
      pattern="\d{3}\-\d{3}\-\d{4}">
```

You aren't confined to the `class` and `href` attributes. Any attribute is up for grabs here. `title`, `alt`, `src`, `id`... you name it, you can style based on a substring within an attribute's value. A common use for the general substring attribute selector is to match a section of a class in pattern library class names. Elaborating on the example above, we can target any class name that starts with "btn" followed by a dash, that also contains the substring "arrow" preceded by a dash:

```
* [class|="btn"] [class*="-arrow"]::after { content: "▼"; }

<button class="btn-small-arrow-active">Click Me</button>
```

The matches are exact: if you include whitespace in your selector, then whitespace must also be present in an attribute's value. The attribute names and values must be case-sensitive only if the underlying document language requires case sensitivity. Class names, titles, URLs and id values are all case-sensitive, but HTML attribute keyterm values, such as `input` types are not.

```
input[type="CHeckBox"] {margin-right: 10px; }

<input type="checkbox" name="rightmargin" value="10px">
```

CSS Selectors level 4 will introduce a case-insensitivity flag. Case-sensitivity of attribute values in selectors will continue to depend on whether the attribute was case-sensitive in the document language in general. Including an `i` before the closing bracket will allow the selector to match the attribute values case-insensitively regardless of document language rules.

```
a[href$=".PDF' i]
```

When supported, the above will match all links pointing to pdf file formats, regardless of how the PDF was saved.

## Matching a substring at the beginning of an attribute value

In cases where you want to select elements based on a substring at the beginning of an attribute value, then the attribute selector pattern `[att^="val"]` is what you're seeking. This can be particularly useful in a situation where you want to style types of links differently, as illustrated in [Figure 15-13](#).

```
a[href^="https:"] {font-weight: bold;}
a[href^="mailto:"] {font-style: italic;}
```

[W3C home page](#)  
[My banking login screen](#)  
[O'Reilly & Associates home page](#)  
[Send mail to me@example.com](mailto:me@example.com)  
[Wikipedia \(English\)](#)

**Figure 15-13.** Selecting elements based on substrings that begin attribute values

Another use case is when you want to style all images in an article that are also figures, as in the figures you see throughout this text. Assuming that the alt text of each figure begins with text in the pattern “Figure 5”—which is an entirely reasonable assumption in this case—then you can select only those

images as follows:

```
img[alt^="Figure"] {border: 2px solid gray; display: block; margin:
```

The potential drawback here is that *any* `img` element whose `alt` starts with “Figure” will be selected, whether or not it’s meant to be an illustrative figure. The likeliness of that occurring depends on the document in question.

Another use case is selecting all of the calendar events that occur on Mondays. In this case, let’s assume all of the events have a `title` attribute containing a date in the format “Monday, March 5th, 2012.” Selecting them all is a simple matter of `[title^="Monday"]`.

## Matching a substring at the end of an attribute value

The mirror image of beginning-substring matching is ending-substring matching, which is accomplished using the `[att$="val"]` pattern. A very common use for this capability is to style links based on the kind of resource they target, such as separate styles for PDF documents, as illustrated in [Figure 15-14](#).

```
a[href$=".pdf"] {font-weight: bold;}
```

[Home page](#)  
[FAQ](#)  
[Printable instructions](#)  
[Detailed warranty](#)  
[Contact us](#)

**Figure 15-14.** Selecting elements based on substrings that end attribute values

Similarly, you could (for whatever reason) select images based on their image format:

```
img[src$=".gif"] {...}  
img[src$=".jpg"] {...}  
img[src$=".png"] {...}
```

To continue the calendar example from the previous section, it would be

possible to select all of the events occurring within a given year using a selector like `[title$="2015"]`.

**Note**

==== You may have noticed that I've quoted all the attribute values in the attribute selectors. Quoting is required if the value includes any special characters, begins with a dash or digit, or is otherwise invalid as an identifier and needs to be quoted as a string. To be safe, I recommend always quoting attribute values in attribute selectors, even though it is only required to make strings out of invalid identifiers. ===

# Using Document Structure

As mentioned previously, CSS is powerful because it uses the structure of documents to determine appropriate styles and how to apply them. That's only part of the story since it implies that such determinations are the only way CSS uses document structure. Structure plays a much larger role in the way styles are applied to a document. Let's take a moment to discuss structure before moving on to more powerful forms of selection.

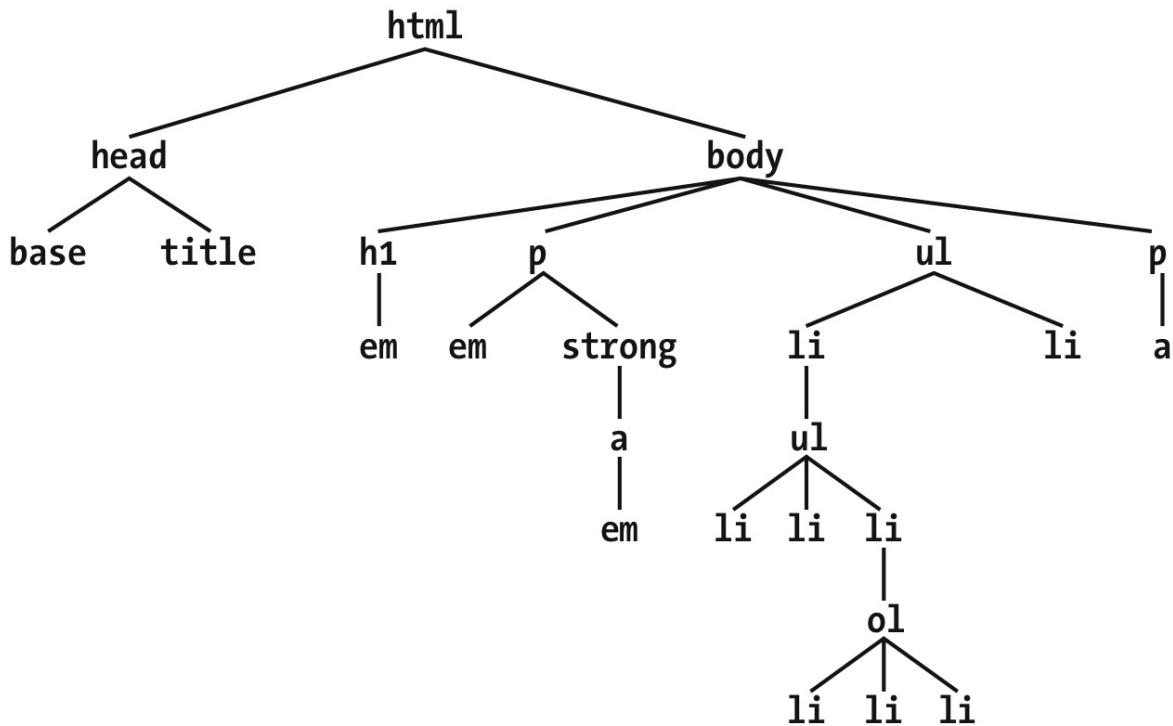
# Understanding the Parent-Child Relationship

To understand the relationship between selectors and documents, you need to once again examine how documents are structured. Consider this very simple HTML document:

```
<html>
<head>
  <base href="http://www.meerkat.web/">
  <title>Meerkat Central</title>
</head>
<body>
  <h1>Meerkat <em>Central</em></h1>
  <p>
    Welcome to Meerkat <em>Central</em>, the <strong>best meerkat we
    on <a href="inet.html">the <em>entire</em> Internet</a></strong>
    <ul>
      <li>We offer:
        <ul>
          <li><strong>Detailed information</strong> on how to adopt a m
          <li>Tips for living with a meerkat</li>
          <li><em>Fun</em> things to do with a meerkat, including:
            <ol>
              <li>Playing fetch</li>
              <li>Digging for food</li>
              <li>Hide and seek</li>
            </ol>
          </li>
        </ul>
      </li>
    </ul>
    <li>...and so much more!</li>
  </ul>
  <p>
    Questions? <a href="mailto:suricate@meerkat.web">Contact us!</a>
  </p>
</body>
</html>
```

Much of the power of CSS is based on the *parent-child relationship* of elements. HTML documents (actually, most structured documents of any

kind) are based on a hierarchy of elements, which is visible in the “tree” view of the document (see [Figure 15-15](#)). In this hierarchy, each element fits somewhere into the overall structure of the document. Every element in the document is either the *parent* or the *child* of another element, and it’s often both.



**Figure 15-15.** A document tree structure

An element is said to be the parent of another element if it appears directly above that element in the document hierarchy. For example, in [Figure 15-15](#), the first `p` element is parent to the `em` and `strong` elements, while `strong` is parent to an anchor (`a`) element, which is itself parent to another `em` element. Conversely, an element is the child of another element if it is directly beneath the other element. Thus, the anchor element in [Figure 15-15](#) is a child of the `strong` element, which is in turn child to the `p` element, and so on.

The terms “parent” and “child” are specific applications of the terms *ancestor* and *descendant*. There is a difference between them: in the tree view, if an element is exactly one level above another, then they have a parent-child relationship. If the path from one element to another is traced through two or

more levels, the elements have an ancestor-descendant relationship, but not a parent-child relationship. (Of course, a child is also a descendant, and a parent is an ancestor.) In [Figure 15-15](#), the first `ul` element is parent to two `li` elements, but the first `ul` is also the ancestor of every element descended from its `li` element, all the way down to the most deeply nested `li` elements.

Also, in [Figure 15-15](#), there is an anchor that is a child of `strong`, but also a descendant of `paragraph`, `body`, and `html` elements. The `body` element is an ancestor of everything that the browser will display by default, and the `html` element is ancestor to the entire document. For this reason, in an HTML or XHTML document, the `html` element is also called the *root element*.

# Descendant Selectors

The first benefit of understanding this model is the ability to define *descendant selectors* (also known as *contextual selectors*). Defining descendant selectors is the act of creating rules that operate in certain structural circumstances but not others. As an example, let's say you want to style only those `em` elements that are descended from `h1` elements. You could put a `class` attribute on every `em` element found within an `h1`, but that's almost as time-consuming as using the `font` tag. It's far more efficient to declare rules that match only `em` elements that are found inside `h1` elements.

To do so, write the following:

```
h1 em {color: gray;}
```

This rule will make gray any text in an `em` element that is the descendant of an `h1` element. Other `em` text, such as that found in a paragraph or a block quote, will not be selected by this rule. [Figure 15-16](#) makes this clear.

## Meerkat Central

[Figure 15-16. Selecting an element based on its context](#)

In a descendant selector, the selector side of a rule is composed of two or more space-separated selectors. The space between the selectors is an example of a *combinator*. Each space combinator can be translated as “found within,” “which is part of,” or “that is a descendant of,” but only if you read the selector right to left. Thus, `h1 em` can be translated as, “Any `em` element that is a descendant of an `h1` element.” (To read the selector left to right, you might phrase it something like, “Any `h1` that contains an `em` will have the following styles applied to the `em`.”)

You aren't limited to two selectors, of course. For example:

```
ul ol ul em {color: gray;}
```

In this case, as [Figure 15-17](#) shows, any emphasized text that is part of an unordered list that is part of an ordered list that is itself part of an unordered list (yes, this is correct) will be gray. This is obviously a very specific selection criterion.

- It's a list
- A right smart list
  1. Within, another list
    - This is *deep*
    - So *very* deep
  2. A list of lists to see
- And all the lists for me!

[Figure 15-17. A very specific descendant selector](#)

Descendant selectors can be extremely powerful. They make possible what could never be done in HTML—at least not without oodles of `font` tags. Let’s consider a common example. Assume you have a document with a sidebar and a main area. The sidebar has a blue background, the main area has a white background, and both areas include lists of links. You can’t set all links to be blue because they’d be impossible to read in the sidebar.

The solution: descendant selectors. In this case, you give the element (probably a `div`) that contains your sidebar a class of `sidebar`, and assign the main area a class of `main`. Then, you write styles like this:

```
.sidebar {background: blue;}  
.main {background: white;}  
.sidebar a:link {color: white;}  
.main a:link {color: blue;}
```

[Figure 15-18](#) shows the result.

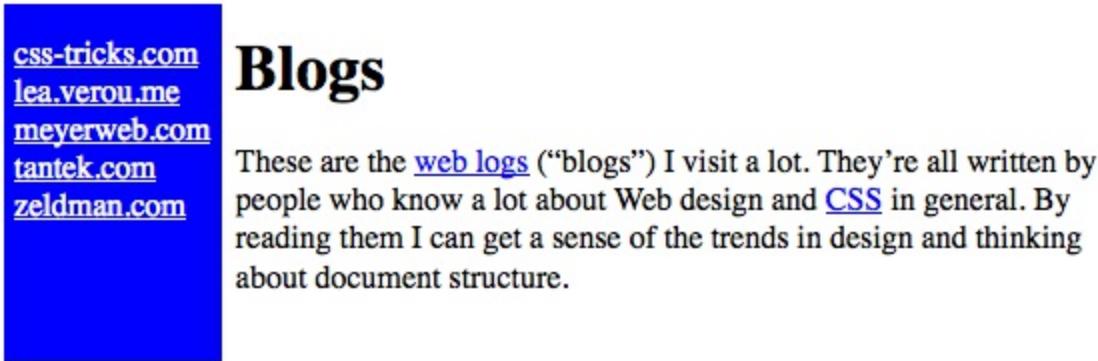


Figure 15-18. Using descendant selectors to apply different styles to the same type of element

**Note**

`:link` refers to links to resources that haven't been visited. We'll talk about it in detail later in this chapter.

Here's another example: let's say that you want gray to be the text color of any `b` (boldface) element that is part of a `blockquote`, and also for any bold text that is found in a normal paragraph:

```
blockquote b, p b {color: gray;}
```

The result is that the text within `b` elements that are descended from paragraphs or block quotes will be gray.

One overlooked aspect of descendant selectors is that the degree of separation between two elements can be practically infinite. For example, if you write `ul em`, that syntax will select any `em` element descended from a `ul` element, no matter how deeply nested the `em` may be. Thus, `ul em` would select the `em` element in the following markup:

```
<ul>
  <li>List item 1
    <ol>
      <li>List item 1-1</li>
      <li>List item 1-2</li>
      <li>List item 1-3
        <ol>
          <li>List item 1-3-1</li>
          <li>List item <em>1-3-2</em></li>
```

```
<li>List item 1-3-3</li>
  </ol>
</li>
<li>List item 1-4</li>
  </ol>
</li>
</ul>
```

Another, even subtler aspect of descendant selectors is that they have no notion of element proximity. In other words, the closeness of two elements within the document tree has no bearing on whether a rule applies or not. This has bearing when it comes to specificity (which we'll cover later on) but also when considering rules that might appear to cancel each other out.

For example, consider the following (which contains a selector type we'll discuss later in this chapter):

```
div:not(.help) span {color: gray;}
div.help span {color: red;}

<div class="help">
  <div class="aside">
    This text contains <span>a span element</span> within.
  </div>
</div>
```

What the CSS says, in effect, is “any `span` inside a `div` that doesn’t have a `class` containing the word `help` should be gray” in the first rule, and “any `span` inside a `div` whose `class` contains the word `help`” in the second rule. In the given markup fragment, *both* rules apply to the `span` shown.

Because the two rules have equal weight and the “red” rule is written last, it wins out and the `span` is red. The fact that the `div class="aside"` is “closer to” the `span` than the `div class="help"` is completely irrelevant. Again: descendant selectors have no notion of element proximity. Both rules match, only one color can be applied, and due to the way CSS works, red is the winner here.

# Selecting Children

In some cases, you don't want to select an arbitrarily descended element; rather, you want to narrow your range to select an element that is a child of another element. You might, for example, want to select a `strong` element only if it is a child (as opposed to any level of descendant) of an `h1` element. To do this, you use the child combinator, which is the greater-than symbol (`>`):

```
h1 > strong {color: red;}
```

This rule will make red the `strong` element shown in the first `h1` below, but not the second:

```
<h1>This is <strong>very</strong> important.</h1>
<h1>This is <em>really <strong>very</strong></em> important.</h1>
```

Read right to left, the selector `h1 > strong` translates as, “Selects any `strong` element that is a direct child of an `h1` element.” The child combinator can be optionally surrounded by whitespace. Thus, `h1 > strong`, `h1> strong`, and `h1>strong` are all equivalent. You can use or omit whitespace as you wish.

When viewing the document as a tree structure, it's easy to see that a child selector restricts its matches to elements that are directly connected in the tree. [Figure 15-19](#) shows part of a document tree.

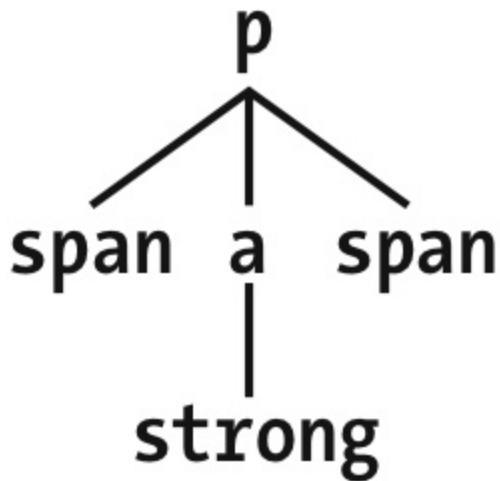


Figure 15-19. A document tree fragment

In this tree fragment, you can easily pick out parent-child relationships. For example, the `a` element is parent to the `strong`, but it is child to the `p` element. You could match elements in this fragment with the selectors `p > a` and `a > strong`, but not `p > strong`, since the `strong` is a descendant of the `p` but not its child.

You can also combine descendant and child combinations in the same selector. Thus, `table.summary td > p` will select any `p` element that is a child of a `td` element that is itself descended from a `table` element that has a `class` attribute containing the word `summary`.

# Selecting Adjacent Sibling Elements

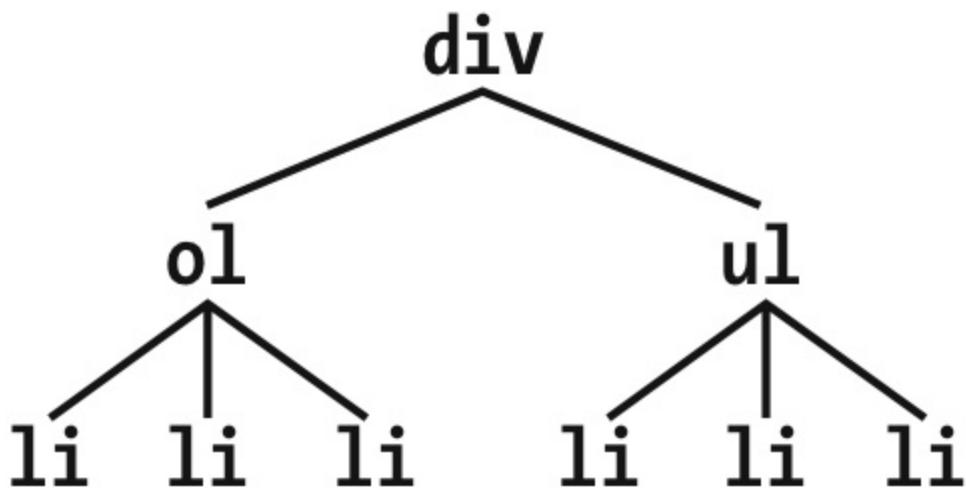
Let's say you want to style the paragraph immediately after a heading or give a special margin to a list that immediately follows a paragraph. To select an element that immediately follows another element with the same parent, you use the *adjacent-sibling combinator*, represented as a plus symbol (+). As with the child combinator, the symbol can be surrounded by whitespace, or not, at the author's discretion.

To remove the top margin from a paragraph immediately following an `h1` element, write:

```
h1 + p {margin-top: 0;}
```

The selector is read as, “Selects any `p` element that immediately follows an `h1` element that *shares a parent* with the `p` element.”

To visualize how this selector works, it is easiest to once again consider a fragment of a document tree, shown in [Figure 15-20](#).



**Figure 15-20.** Another document tree fragment

In this fragment, a pair of lists descends from a `div` element, one ordered and

the other not, each containing three list items. Each list is an adjacent sibling, and the list items themselves are also adjacent siblings. However, the list items from the first list are *not* siblings of the second, since the two sets of list items do not share the same parent element. (At best, they're cousins, and CSS has no cousin selector.)

Remember that you can select the second of two adjacent siblings only with a single combinator. Thus, if you write `li + li {font-weight: bold;}`, only the second and third items in each list will be boldfaced. The first list items will be unaffected, as illustrated in [Figure 15-21](#).

1. List item 1
2. **List item 1**
3. **List item 1**

This is some text that is part of the 'div'.

- A list item
- **Another list item**
- **Yet another list item**

**Figure 15-21.** Selecting adjacent siblings

To work properly, CSS requires that the two elements appear in “source order.” In our example, an `ol` element is followed by a `ul` element. This allows you to select the second element with `ol + ul`, but you cannot select the first using the same syntax. For `ul + ol` to match, an ordered list must immediately follow an unordered list.

Keep in mind that text content between two elements does *not* prevent the adjacent-sibling combinator from working. Consider this markup fragment, whose tree view would be the same as that shown in [Figure 15-19](#):

```
<div>
  <ol>
    <li>List item 1</li>
    <li>List item 1</li>
    <li>List item 1</li>
  </ol>
  This is some text that is part of the 'div'.
  <ul>
```

```
<li>A list item</li>
<li>Another list item</li>
<li>Yet another list item</li>
</ul>
</div>
```

Even though there is text between the two lists, you can still match the second list with the selector `ol + ul`. That's because the intervening text is not contained with a sibling element, but is instead part of the parent `div`. If you wrapped that text in a `paragraph` element, it would then prevent `ol + ul` from matching the second list. Instead, you might have to write something like `ol + p + ul`.

As the following example illustrates, the adjacent-sibling combinator can be used in conjunction with other combinators:

```
html > body table + ul{margin-top: 1.5em;}
```

The selector translates as, “Selects any `ul` element that immediately follows a sibling `table` element that is descended from a `body` element that is itself a child of an `html` element.”

As with all combinators, you can place the adjacent-sibling combinator in a more complex setting, such as `div#content h1 + div ol`. That selector is read as, “Selects any `ol` element that is descended from a `div` when the `div` is the adjacent sibling of an `h1` which is itself descended from a `div` whose `id` attribute has a value of `content`.”

# Selecting Following Siblings

Selectors Level 3 introduced a new sibling combinator called the *general sibling combinator*. This lets you select any element that follows another element when both elements share the same parent, represented using the tilde (~) combinator.

As an example, to italicize any `ol` that follows an `h2` and also shares a parent with the `h2`, you'd write `h2 ~ol {font-style: italic;}`. The two elements do not have to be adjacent siblings, although they can be adjacent and still match this rule. The result of applying this rule to the following markup is shown in [Figure 15-22](#).

```
<div>
  <h2>Subheadings</h2>
  <p>It is the case that not every heading can be a main heading.
    subheadings. Examples include:</p>
  <ol>
    <li>Headings that are less important</li>
    <li>Headings that are subsidiary to more important headlines<
        <li>Headings that like to be dominated</li>
      </ol>
    <p>Let's restate that for the record:</p>
    <ol>
      <li>Headings that are less important</li>
      <li>Headings that are subsidiary to more important headlines<
          <li>Headings that like to be dominated</li>
        </ol>
    </div>
```

## Subheadings

It is the case that not every heading can be a main heading. Some headings must be subheadings. Examples include:

1. *Headings that are less important*
2. *Headings that are subsidiary to more important headlines*
3. *Headings that like to be dominated*

Let's restate that for the record:

1. *Headings that are less important*
2. *Headings that are subsidiary to more important headlines*
3. *Headings that like to be dominated*

Figure 15-22. Selecting following siblings

As you can see, both ordered lists are italicized. That's because both of them are `ol` elements that follow an `h2` with whom they share a parent (the `div`).

# Pseudo-Class Selectors

Things get really interesting with *pseudo-class selectors*. These selectors let you assign styles to what are, in effect, phantom classes that are inferred by the state of certain elements, or markup patterns within the document, or even by the state of the document itself.

The phrase “phantom classes” might seem a little odd, but it really is the best way to think of how pseudo-classes work. For example, suppose you wanted to highlight every other row of a data table. You could do that by marking up every other row something like `class="even"` and then writing CSS to highlight rows with that class—or (as we’ll soon see) you could use a pseudo-class selector to achieve exactly the same effect, and through very similar means.

# Combining Pseudo-Classes

Before we start, a word about chaining. CSS makes it possible to combine (“chain”) pseudo-classes together. For example, you can make unvisited links red when they’re hovered, but visited links maroon when *they’re* hovered:

```
a:link:hover {color: red;}  
a:visited:hover {color: maroon;}
```

The order you specify doesn’t actually matter; you could also write `a:hover:link` to the same effect as `a:link:hover`. It’s also possible to assign separate hover styles to unvisited and visited links that are in another language—for example, German:

```
a:link:hover:lang(de) {color: gray;}  
a:visited:hover:lang(de) {color: silver;}
```

Be careful not to combine mutually exclusive pseudo-classes. For example, a link cannot be both visited and unvisited, so `a:link:visited` doesn’t make any sense.

# Structural Pseudo-Classes

Thanks to Selectors Level 3, the majority of pseudo-classes are structural in nature; that is, they refer to the markup structure of the document. Most of them depend on patterns within the markup, such as choosing every third paragraph, but others allow you to address specific types of elements. All pseudo-classes, without exception, are a word preceded by a single colon (:), and they can appear anywhere in a selector.

Before we get started, there's an aspect of pseudo-classes that needs to be made explicit here: pseudo-classes always refer to the element to which they're attached, and no other. Seems like a weirdly obvious thing to say, right? The reason to make it explicit is that for a few of the structural pseudo-classes in particular, it's a common error to think they are descriptors that refer to descendant elements.

To illustrate this, I'd like to share a personal anecdote. When my eldest daughter, also my first child, was born in 2003, I announced it online (like you do). A number of people responded with congratulations and CSS jokes, chief among them the selector `#ericmeyer:first-child`. The problem there is that selector would select me, and then only if I were the first child of my parents (which, as it happens, I am). To properly select my first child, that selector would need to be `#ericmeyer > :first-child`.

The confusion is understandable, which is why we're addressing it here; reminders will be found throughout the following sections. Just always keep in mind that the effect of pseudo-classes is to apply a sort of a "phantom class" to the element to which they're attached, and you should be okay.

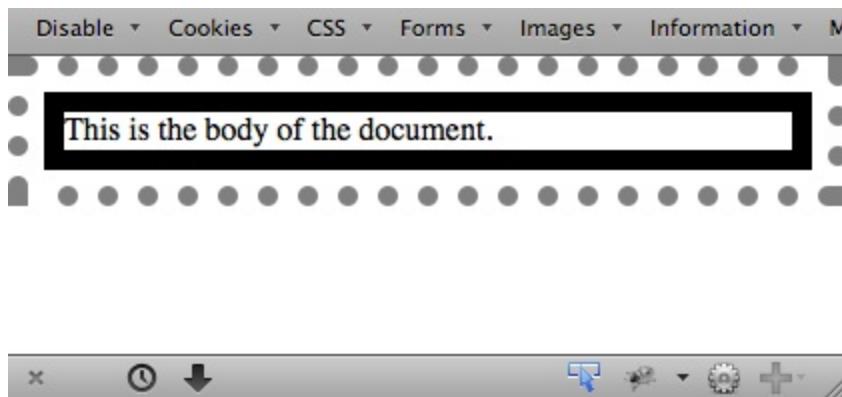
## Selecting the root element

This is the quintessence of structural simplicity: the pseudo-class `:root` selects the root element of the document. In HTML, this is *always* the `html` element. The real benefit of this selector is found when writing style sheets for XML languages, where the root element may be different in every

language—for example, in RSS 2.0 it's the `rss` element—or even when you have more than one possible root element within a single language (though not, of course, a single document!).

Here's an example of styling the root element in HTML, as illustrated in [Figure 15-23](#):

```
:root {border: 10px dotted gray;}  
body {border: 10px solid black;}
```



**Figure 15-23.** Styling the root element

Of course, in HTML documents you can always select the `html` element directly, without having to use the `:root` pseudo-class. There is a difference between the two selectors in terms of specificity, which we'll cover later on.

## Selecting empty elements

With the pseudo-class `:empty`, you can select any element that has no children of any kind, *including* text nodes, which covers both text and whitespace. This can be useful in suppressing elements that a CMS has generated without filling in any actual content. Thus, `p:empty {display: none;}` would prevent the display of any empty paragraphs.

Note that in order to be matched, an element must be, from a parsing perspective, truly empty—no whitespace, visible content, or descendant elements. Of the following elements, only the first and last would be matched by `p:empty`.

```
<p></p>
<p> </p>
<p>
</p>
<p><!--a comment--></p>
```

The second and third paragraphs are not matched by `:empty` because they are not empty: they contain, respectively, a single space and a single newline character. Both are considered text nodes, and thus prevent a state of emptiness. The last paragraph matches because comments are not considered content, not even whitespace. But put even one space or newline to either side of that comment, and `p:empty` would fail to match.

**Note**

CSS Selectors Level 4 will likely include a `:blank` pseudo-class, that will match the four paragraphs above. `:blank` is defined to be similar to `:empty`, in matching empty elements, but to also match elements that contain only white space.

You might be tempted to just style all empty elements with something like `*:empty {display: none;}`, but there's a hidden catch: `:empty` matches HTML's empty elements, like `img` and `input`. It could even match `textarea`, unless of course you insert some default text into the `textarea` element. Thus, in terms of matching elements, `img` and `img:empty` are effectively the same. (They are different in terms of specificity, which we'll cover in just a bit.)

```

<br>
<input type="number" min="-1" max="1" step=".01"/>
<textarea></textarea>
```

**Note**

As of early 2015, `:empty` is unique in that it's the only CSS selector that takes text nodes into consideration when determining matches. Every other selector type in Selectors Level 3 considers only elements and ignores text nodes entirely—recall, for example, the sibling combinators discussed previously.

## Selecting unique children

If you've ever wanted to select all the images that are wrapped by a hyperlink element, the `:only-child` pseudo-class is for you. It selects elements when they are the only child element of another element. So let's say you want to add a border to any image that's the only child of another element. You'd write:

```
img:only-child {border: 1px solid black;}
```

This would match any image that meets those criteria, of course. Therefore, if you had a paragraph which contained an image and no other child elements, the image would be selected regardless of all the text surrounding it. If what you're really after is images that are sole children and found inside hyperlinks, then you just modify the selector like so (which is illustrated in [Figure 15-24](#)):

```
a[href] img:only-child {border: 2px solid black;}  
  
<a href="http://w3.org/"></a>  
<a href="http://w3.org/"> The W3C</a>  
<a href="http://w3.org/"> <em>The W3C</em>  
<a href="http://w3.org/"><em> The W3C</em>
```



**Figure 15-24.** Selecting images that are only children inside links

There are two things to remember about `:only-child`. The first is that you *always* apply it to the element you want to be an only child, not to the parent element, as explained earlier. And that brings up the second thing to remember, which is that when you use `:only-child` in a descendant selector, you aren't restricting the elements listed to a parent-child relationship. To go back to the hyperlinked-image example, `a[href] img:only-child` matches any image that is an only child and is descended from an `a` element, not a child of an `a` element. To match, the element image must be the only child of

its direct parent, and a descendant of a link, but that parent can itself be a descendant of that link. Therefore all four of the images here would be matched, as shown in [Figure 15-25](#).

```
a[href] img:only-child {border: 5px solid black;}  
  
<a href="http://w3.org/"></a>  
<a href="http://w3.org/"><span></span>  
<a href="http://w3.org/">A link to <span>the  img:only-child`. With that change, only the first of the three images shown in [Figure 15-25](#) would be matched.

That's all great, but what if you want to match images that are the only images inside hyperlinks, but there are other elements in there with them? Consider the following:

```
<a href="http://w3.org/"><b>•</b></a>
```

In this case, we have an `a` element that has two children: a `b` and an `img`. That image, no longer being the only child of its parent (the hyperlink), can never be matched using `:only-child`. However, it *can* be matched using `:only-of-type`. This is illustrated in [Figure 15-26](#).

```
a[href] img:only-of-type {border: 5px solid black;}  
  
<a href="http://w3.org/"><b>•</b></a>  
<a href="http://w3.org/"><span><b>•</b> img:only-of-type {float: right; margin: 20px;}
```

As long as there aren't multiple images that are children of a paragraph, then the image will be floated. You could also use this pseudo-class to apply extra styles to an `h2` when it's the only one in a section of a document.

```
section > h2 {margin: 1em 0 0.33em; font-size: 1.8rem; border-bot  
section > h2:only-of-type {font-size: 2.4rem;}}
```

Given those rules, any `section` that has only one child `h2` will have it appear larger than usual. If there are two or more `h2` children to a `section`, neither of them will be larger than the other. The presence of other children—whether they are other heading levels, paragraphs, tables, paragraphs, lists, and so on—will not interfere with matching.

```
*.foo:only-of-type {color: red;}  
  
<p class="foo">This paragraph has a class foo</p>  
<p>This paragraph doesn't have a class</p>
```

The `:only-of-type` pseudoclass matches elements that are the *only element* of that type. In the above example, the selector will match any element that is the only child of its type within a parent selector that also has the class `foo`. While only one element has the class `foo`, the `p` is not the only of its type, and

therefore nothing will be matched.

## Selecting first and last children

It's pretty common to want to apply special styling to the first or last child of an element. The most common example is styling a bunch of navigation links into a tab bar, and wanting to put some special visual touches on the first or last tab (or both). In the past, this was done by applying special classes to those elements. Now we have pseudo-classes to carry the load for us.

The pseudo-class `:first-child` is used to select elements that are the first children of other elements. Consider the following markup:

```
<div>
  <p>These are the necessary steps:</p>
  <ul>
    <li>Insert key</li>
    <li>Turn key <strong>clockwise</strong></li>
    <li>Push accelerator</li>
  </ul>
  <p>
    Do <em>not</em> push the brake at the same time as the accele
  </p>
</div>
```

In this example, the elements that are first children are the first `p`, the first `li`, and the `strong` and `em` elements, which are all the first children of their respective parents. Given the following two rules:

```
p:first-child {font-weight: bold;}
li:first-child {text-transform: uppercase;}
```

...you get the result shown in [Figure 15-27](#).

**These are the necessary steps:**

- **INSERT KEY**
- Turn key **clockwise**
- Push accelerator

Do *not* push the brake at the same time as the accelerator.

**Figure 15-27. Styling first children**

The first rule boldfaces any `p` element that is the first child of another element. The second rule uppercases any `li` element that is the first child of another element (which, in HTML, must be either an `ol` or `ul` element).

As has been mentioned, the most common error is assuming that a selector like `p:first-child` will select the first child of a `p` element. However, remember the nature of pseudo-classes, which is to attach a sort of phantom class to the element associated with the pseudo-class. If you were to add actual classes to the markup, it would look like this:

```
<div>
  <p class="first-child">These are the necessary steps:</p>
  <ul>
    <li class="first-child">Insert key</li>
    <li>Turn key <strong class="first-child">clockwise</strong></li>
    <li>Push accelerator</li>
  </ul>
  <p>
    Do <em class="first-child">not</em> push the brake at the same
    accelerator.
  </p>
</div>
```

Therefore, if you want to select those `em` elements that are the first child of another element, you write `em:first-child`.

The mirror image of `:first-child` is `:last-child`. If we take the previous example and just change the pseudo-classes, we get the result shown in [Figure 15-28](#).

```
p:last-child {font-weight: bold;}
li:last-child {text-transform: uppercase;}

<div>
  <p>These are the necessary steps:</p>
  <ul>
    <li>Insert key</li>
    <li>Turn key <strong>clockwise</strong></li>
    <li>Push accelerator</li>
  </ul>
  <p>
```

```
Do <em>not</em> push the brake at the same time as the accele  
</p>  
</div>
```

These are the necessary steps:

- Insert key
- Turn key **clockwise**
- PUSH ACCELERATOR

**Do *not* push the brake at the same time as the accelerator.**

**Figure 15-28. Styling last children**

The first rule boldfaces any `p` element that is the last child of another element. The second rule uppercases any `li` element that is the last child of another element. If you wanted to select the `em` element inside that last paragraph, you could use the selector `p:last-child em`, which selects any `em` element that descends from a `p` element that is itself the last child of another element.

Interestingly, you can combine these two pseudo-classes to create a version of `:only-child`. The following two rules will select the same elements:

```
p:only-child {color: red; }  
p:first-child:last-child {background-color: red; }
```

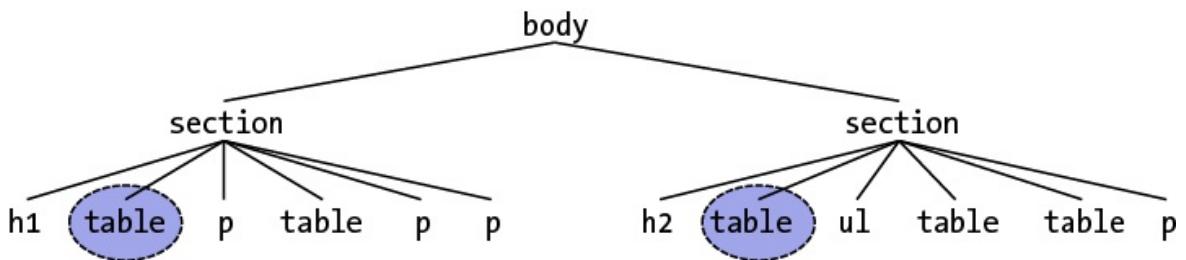
Either way, you'd get paragraphs with red foreground and background colors (not a good idea, clearly). The only difference is in terms of specificity, which we'll cover later in this book.

## Selecting first and last of a type

In a manner similar to selecting the first and last children of an element, you can select the first or last of a type of element within an element. This permits things like selecting the first `table` inside a given element, regardless of whatever other elements come before it.

```
table:first-of-type {border-top: 2px solid gray; }
```

Note that this does *not* apply to the entire document; that is, the rule shown will not select the first `table` in the document and skip all the others. It will instead select the first `table` element within each element that contains one, and skip any sibling `table` elements that come after the first. Thus, given the document structure shown in [Figure 15-29](#), the circled nodes are the ones that are selected.



**Figure 15-29. Selecting first-of-type tables**

Within the context of tables, a useful way to select the first data cell within a row regardless of whether a header cell comes before it in the row is as follows:

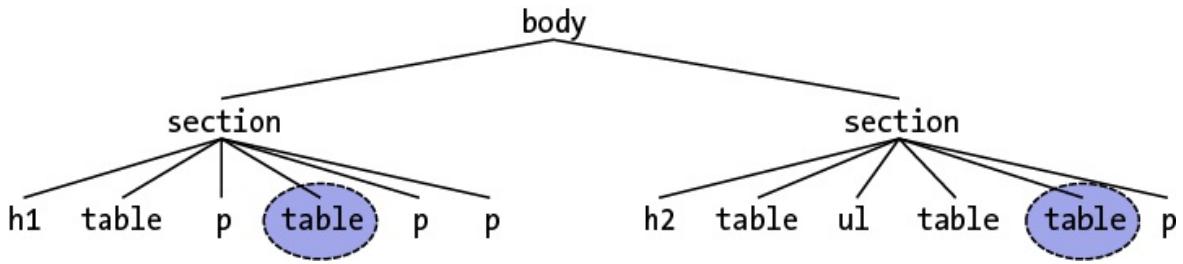
```
td:first-of-type {border-left: 1px solid red;}
```

That would select the first data cell in each of the following table rows:

```
<tr><th scope="row">Count</th><td>7</td><td>6</td><td>11</td></tr>
<tr><td>Q</td><td>X</td><td>-</td></tr>
```

Compare that to the effects of `td:first-child`, which would select the first `td` element in the second row, but not in the first row.

The flip side is `:last-of-type`, which selects the last instance of a given type from amongst its sibling elements. In a way, it's just like `:first-of-type` except you start with the last element in a group of siblings and walk backwards toward the first element until you reach an instance of the type. Given the document structure shown in [Figure 15-30](#), the circled nodes are the ones selected by `table:last-of-type`.



**Figure 15-30. Selecting last-of-type tables**

As was noted with `:only-of-type`, remember that you are selecting elements of a type from among their sibling elements; thus, every set of siblings is considered separately. In other words, you are *not* selecting the first (or last) of all the elements of a type within the entire document as a single group. Each set of elements that share a parent is its own group, and you can select the first (or last) of a type within each group.

Similar to what was noted in the previous section, you can combine these two pseudo-classes to create a version of `:only-of-type`. The following two rules will select the same elements:

```
table:only-of-type{color: red;}
table:first-of-type:last-of-type {background: red;}
```

## Selecting every nth child

If you can select elements that are the first, last, or only children of other elements, how about every third child? All even children? Only the ninth child? Rather than define a literally infinite number of named pseudo-classes, CSS has the `:nth-child()` pseudo-class. By filling integers or even simple algebraic expressions into the parentheses, you can select any arbitrarily numbered child element you like.

Let's start with the `:nth-child()` equivalent of `:first-child`, which is `:nth-child(1)`. In the following example, the selected elements will be the first paragraph and the first list item.

```
p:nth-child(1) {font-weight: bold;}
li:nth-child(1) {text-transform: uppercase;}
```

```

<div>
  <p>These are the necessary steps:</p>
  <ul>
    <li>Insert key</li>
    <li>Turn key <strong>clockwise</strong></li>
    <li>Push accelerator</li>
  </ul>
  <p>
    Do <em>not</em> push the brake at the same time as the accele
  </p>
</div>

```

If we were to change the numbers from 1 to 2, however, then no paragraphs would be selected, and the middle (or second) list item would be selected, as illustrated in [Figure 15-31](#).

```

p:nth-child(2) {font-weight: bold;}
li:nth-child(2) {text-transform: uppercase;}

```

These are the necessary steps:

- Insert key
- TURN KEY **CLOCKWISE**
- Push accelerator

Do *not* push the brake at the same time as the accelerator.

**Figure 15-31. Styling second children**

You can of course insert any integer you choose; if you have a use case for selecting any ordered list that is the 93rd child element of its parent, then `ol:nth-child(93)` is ready to serve. This will match the 93rd child of any parent as long as that child is an ordered list. (This does not mean the 93rd ordered list among its siblings; see the next section for that.)

More powerfully, you can use simple algebraic expressions in the form  $a \cdot n + b$  or  $a \cdot n - b$  to define recurring instances, where  $a$  and  $b$  are integers and  $n$  is present as itself. Furthermore, the  $+ b$  or  $- b$  part is optional and thus can be dropped if it isn't needed.

Let's suppose we want to select every third list item in an unordered list,

starting with the first. The following makes that possible, selecting the first and fourth items, as shown in [Figure 15-32](#).

```
ul > li:nth-child(3n + 1) {text-transform: uppercase;}
```

These are the necessary steps:

- INSERT KEY
- Turn key **clockwise**
- Grip steering wheel with hands
- PUSH ACCELERATOR
- Steer vehicle
- Use brake as necessary

Do *not* push the brake at the same time as the accelerator.

**Figure 15-32.** Styling every third list item

The way this works is that  $n$  represents the series 0, 1, 2, 3, 4, ...and on into infinity. The browser then solves for  $3_n + 1$ , yielding 1, 4, 7, 10, 13, ...and so on. Were we to drop the  $+1$ , thus leaving us with simply  $3n$ , the results would be 0, 3, 6, 9, 12, ...and so on. Since there is no zeroth list item—all element counting starts with one, to the likely chagrin of array-slingers everywhere—the first list item selected by this expression would be the third list item in the list.

Given that element counting starts with one, it's a minor trick to deduce that `:nth-child(2n)` will select even-numbered children, and either `:nth-child(2n+1)` or `:nth-child(2n-1)` will select odd-numbered children. You can commit that to memory, or you can use the two special keywords that `:nth-child()` accepts: `even` and `odd`. Want to highlight every other row of a table, starting with the first? Here's how you do it, as shown in [Figure 15-33](#).

```
tr:nth-child(odd) {background: silver;}
```

STATE	ISO	JACKSON	NATIONAL MOCKINGBIRD
Missouri	MO	Jefferson City	Eastern Bluebird
Montana	MT	Helena	Western Meadowlark
Nebraska	NE	Lincoln	Western Meadowlark
Nevada	NV	Carson City	Mountain Bluebird
New Hampshire	NH	Concord	Purple Finch
New Jersey	NJ	Trenton	Eastern Goldfinch
New Mexico	NM	Santa Fe	Roadrunner
New York	NY	Albany	Eastern Bluebird
North Carolina	NC	Raleigh	Northern Cardinal
North Dakota	ND	Bismarck	Western Meadowlark
Ohio	OH	Columbus	Northern Cardinal
Oklahoma	OK	Oklahoma City	Scissor-Tailed Flycatcher
Oregon	OR	Salem	Western Meadowlark
Pennsylvania	PA	Harrisburg	Ruffed Grouse

Figure 15-33. Styling every other table row

Anything more complex than every-other-element requires an  $a n + b$  expression.

Note that when you want to use a negative number for  $b$ , you have to remove the  $+$  sign or else the selector will fail entirely. Of the following two rules, only the first will do anything. The second will be dropped by the parser and ignored.

```
tr:nth-child(4n - 2) {background: silver;}
tr:nth-child(3n + -2) {background: red;}
```

If you wanted to select every row starting with the 9th, you can use either of the following. They are similar in that they will select all rows starting with the 9th, but the latter one has greater specificity, which we discuss later.

```
tr:nth-child(n + 9) {background: silver;}
tr:nth-child(8) ~ tr {background: silver;}
```

As you might expect, there is a corresponding pseudo-class in `:nth-last-child()`. This lets you do the same thing as `:nth-child()`, except with `:nth-last-child()` you start from the last element in a list of siblings and count backwards toward the beginning. If you're intent on highlighting every

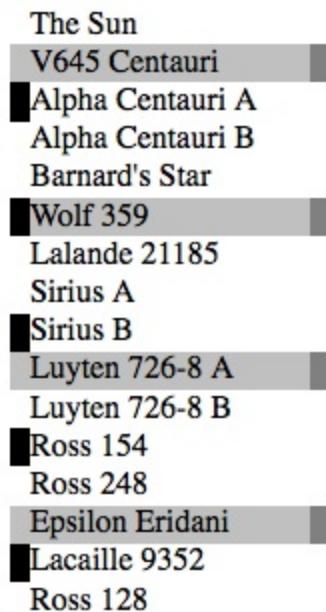
other table row *and* making sure the very last row is one of the rows in the highlighting pattern, either one of these will work for you:

```
tr:nth-last-child(odd) {background: silver;}  
tr:nth-last-child(2n+1) {background: silver;} /* equivalent */
```

If the DOM is updated to add or remove table rows, there is no need to add or remove classes. By using structural selectors, these selectors will always match the odd rows of the updated DOM.

Of course, any element can be matched using both `:nth-child()` and `:nth-last-child()` if it fits the criteria. Consider these rules, the results of which are shown in [Figure 15-34](#).

```
li:nth-child(3n + 3) {border-left: 5px solid black;}  
li:nth-last-child(4n - 1) {border-right: 5px solid black;}
```



**Figure 15-34. Combining patterns of `:nth-child()` and `:nth-last-child()`**

It's also the case that you can string these two pseudo-classes together as `:nth-child(1):nth-last-child(1)`, thus creating a more verbose restatement of `:only-child`. There's no real reason to do so other than to create a selector with a higher specificity, but the option is there.

You can use CSS to determine how many list-items are in a list, and style them accordingly.

```
li:only-child {width: 100%;}
li:nth-child(1):nth-last-child(2),
li:nth-child(2):nth-last-child(1) {width: 50%;}
li:nth-child(1):nth-last-child(3),
li:nth-child(1):nth-last-child(3) ~ li {width: 33.33%;}
li:nth-child(1):nth-last-child(4),
li:nth-child(1):nth-last-child(4) ~ li {width: 25%;}
```

You can use CSS to determine how many list-items are in a list, and style them accordingly. In the above examples, if a list-item is the only list item, then the width is 100%. If a list item is the first item and also the second from last item, that means there are 2 items, and we made the width 50%. If an item is the first item and also the third from the last item, then we made it, and the two sibling list items following it, 33% wide. Similarly, if a list item is the first item and also the fourth from the last item, it means that there are exactly four items, so we made it, and its 3 siblings, 25% of the width.

## Selecting every nth of a type

In what's no doubt become a very familiar pattern, the `:nth-child()` and `:nth-last-child()` pseudo-classes have analogues in `:nth-of-type()` and `:nth-last-of-type()`. You can, for example, select every other hyperlink that's a child of any given paragraph, starting with the second, using `p > a:nth-of-type(even)`. This will ignore all other elements (spans, strongs, etc.) and consider only the links, as demonstrated in [Figure 15-35](#):

```
p > a:nth-of-type(even) {background: blue; color: white;}
```

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(Text courtesy <http://andrewdavidson.com/gibberish/>)

**Figure 15-35. Selecting the even-numbered links**

If you wanted to work from the last hyperlink backwards, then of course you'd use `p > a:nth-last-of-type(even)`.

As before, these select elements of a type from among their sibling elements, *not* from among all the elements of a type within the entire document as a single group. Each element has its own list of siblings, and selections happen within each group.

As you might expect, you can string these two together as `:nth-of-type(1) :nth-last-of-type(1)` to restate `:only-of-type`, only with higher specificity. (We *will* explain specificity later in this book, I promise.)

# Dynamic Pseudo-Classes

Beyond the structural pseudo-classes, there are a set of pseudo-classes that relate to structure but can change based on changes made to the page after it's been rendered. In other words, the styles are applied to pieces of a document based on something in addition to the structure of the document, and in a way that cannot be precisely deduced simply by studying the document's markup.

It may sound like we're applying styles at random, but not so. Instead, we're applying styles based on somewhat ephemeral conditions that can't be predicted in advance. Nevertheless, the circumstances under which the styles will appear are, in fact, well-defined. Think of it this way: during a sporting event, whenever the home team scores, the crowd will cheer. You don't know exactly when during a game the team will score, but when it does, the crowd will cheer, just as predicted. The fact that you can't predict the moment of the cause doesn't make the effect any less expected.

Consider the anchor element (`a`), which (in HTML and related languages) establishes a link from one document to another. Anchors are always anchors, of course, but some anchors refer to pages that have already been visited, while others refer to pages that have yet to be visited. You can't tell the difference by simply looking at the HTML markup, because in the markup, all anchors look the same. The only way to tell which links have been visited is by comparing the links in a document to the user's browser history. So there are actually two basic types of anchors: visited and unvisited.

## Hyperlink pseudo-classes

CSS2.1 defines two pseudo-classes that apply only to hyperlinks. In HTML, these are any `a` elements with an `href` attribute; in XML languages, they're any elements that act as links to another resource. [Table 15-2](#) describes these two pseudo-classes.

Table 15-2. Link pseudo-classes

Name	Description
------	-------------

:link	Refers to any anchor that is a hyperlink (i.e., has an <code>href</code> attribute) and points to an address that has not been visited.
:visited	Refers to any anchor that is a hyperlink to an already visited address. For security reasons, the styles that can be applied to visited links are severely limited; see sidebar “ <a href="#">Visited links and privacy</a> ” for details.

The first of the pseudo-classes in [Table 15-2](#) may seem a bit redundant. After all, if an anchor hasn’t been visited, then it must be unvisited, right? If that’s the case, all we should need is the following:

```
a {color: blue;}
a:visited {color: red;}
```

Although this format seems reasonable, it’s actually not quite enough. The first of the rules shown here applies not only to unvisited links, but also to placeholder links such as this one:

```
<a>4. The Lives of Meerkats</a>
```

The resulting text would be blue because the `a` element will match the rule `a {color: blue;}`, as shown above. Therefore, to avoid applying your link styles to placeholders, use the `:link` and `:visited` pseudo-classes:

```
a:link {color: blue;}      /* unvisited links are blue */
a:visited {color: red;}    /* visited links are red */
```

As you may or may not have already realized, the `:link` and `:visited` pseudo-class selectors are functionally equivalent to the early-1990s `body` attributes `link` and `vlink`. Assume that an author wants all anchors to unvisited pages to be purple and anchors to visited pages to be silver. Back in the days of HTML 3.2, this could be specified as follows:

```
<body link="purple" vlink="silver">
```

Don’t do this. Instead, use CSS. In CSS, the effect is accomplished with:

```
a:link {color: purple;}  
a:visited {color: silver;}
```

This is a good place to revisit attribute and class selectors and show how they can be combined with pseudo-classes. For example, let's say you want to change the color of links that point outside your own site. In most circumstances we can use the starts-with attribute selector. However, some CMS's set all links to be absolute URLs, in which case you could assign a class to each of these anchors, it's easy:

```
<a href="/about.html">My About page</a>  
<a href="https://www.site.net/" class="external">An external site
```

To apply different styles to the external link, all you need is a rule like this:

```
a.external:link, a[href^="http"]:link { color: slateblue; }  
a.external:visited, a[href^="http"]:visited {color: maroon; }
```

This rule will make the second anchor in the preceding markup slateblue by default, and maroon once visited, while the first anchor will remain the default color for hyperlinks (usually blue when not-visited and purple once visited). For improved usability and accessibility, visited links should be easily differentiable from non-visited links.

#### Note

Styled visited links enables visitors to know where they have been and what they have yet to visit. This is especially important on large websites where it may be difficult to remember, especially for those with cognitive disabilities, which pages have been visited. Not only is highlighting visited links one of the W3C Web Content Accessibility Guidelines, but it makes searching for content faster, more efficient and less stressful for everyone.

The same general syntax is used for ID selectors as well:

```
a#footer-copyright:link{background: yellow; }  
a#footer-copyright:visited {background: gray; }
```

You can chain the two link-state pseudo-classes together, but there's no reason why you ever would: a link cannot be both visited and unvisited at the

same time!

## Visited links and privacy

For well over a decade, it was possible to style visited links with any CSS properties available, just as you could unvisited links. However, in the mid-2000s several people demonstrated that one could use visual styling and simple DOM scripting to determine if a user had visited a given page. For example, given the rule `:visited {font-weight: bold;}` a script could find all of the boldfaced links and tell the user which of those sites they'd visited—or, worse still, report those sites back to a server. A similar, non-scripted tactic uses background images to achieve the same result.

While this might not seem terribly serious to you, it can be utterly devastating for a web user in a country where one can be jailed for visiting certain sites—opposition parties, unsanctioned religious organizations, “immoral” or “corrupting” sites, and so on. It can also be used by phishing sites to determine which online banks a user has visited. Thus, two steps were taken.

The first step is that only color-related properties can be applied to visited links: `color`, `background-color`, `column-rule-color`, `outline-color`, `border-color`, and the individual-side border color properties (e.g., `border-top-color`). Attempts to apply any other property to a visited link will be ignored. Furthermore, any styles defined for `:link` will be applied to visited links as well as unvisited links, which effectively makes `:link` “style any hyperlink,” instead of “style any unvisited hyperlink.”

The second step is that if a visited link has its styles queried via the DOM, the resulting value will be as if the link were not visited. Thus, if you've defined visited links to be purple rather than unvisited links' blue, even though the link will appear purple onscreen, a DOM query of its color will return the blue value, not the purple.

As of mid-2015, this behavior is present throughout all browsing modes, not just “private browsing” modes. Even though we're limited in how we can use CSS to differentiate visited links from non-visited links, it is important for usability and accessibility to use the limited styles supported by `:visited` links

to differentiate them from unvisited links.

## User action pseudo-classes

CSS defines a few pseudo-classes that can change a document's appearance based on actions taken by the user. These dynamic pseudo-classes have traditionally been used to style hyperlinks, but the possibilities are much wider. [Table 15-3](#) describes these pseudo-classes.

Table 15-3. User action pseudo-classes

Name	Description
:focus	Refers to any element that currently has the input focus—i.e., can accept keyboard input or be activated in some way.
:hover	Refers to any element over which the mouse pointer is placed—e.g., a hyperlink over which the mouse pointer is hovering.
:active	Refers to any element that has been activated by user input—e.g., a hyperlink on which a user clicks during the time the mouse button is held down.

Elements that can become :active include links, buttons, menuitems and any element with a tabindex value. These elements all other interactive elements, including form controls and elements that are contenteditable, can also receive focus.

As with :link and :visited, these pseudo-classes are most familiar in the context of hyperlinks. Many web pages have styles that look like this:

```
a:link {color: navy;}  
a:visited {color: gray;}  
a:focus {color: orange;}  
a:hover {color: red;}  
a:active {color: yellow;}
```

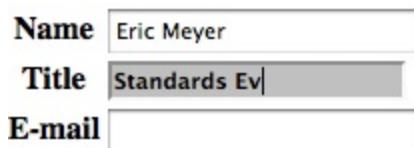
**Note**

The order of the pseudo-classes is more important than it might seem at first. The usual recommendation is “link-visited-hover-active,” although this has been modified to “link-visited-focus-hover-active.” The next chapter explains why this particular ordering is important and discusses several reasons you might choose to change or even ignore the recommended ordering.

Notice that the dynamic pseudo-classes can be applied to any element, which is good since it’s often useful to apply dynamic styles to elements that aren’t links. For example, using this markup:

```
input:focus {background: silver; font-weight: bold;}
```

...you could highlight a form element that is ready to accept keyboard input, as shown in [Figure 15-36](#).



**Figure 15-36. Highlighting a form element that has focus**

**Note**

While you can style element with `:focus` anyway you like, do not remove all styling from focused elements, as differentiating which element currently has focus is vital for accessibility, especially for those navigating your site or application with a keyboard.

You can also perform some rather odd feats by applying dynamic pseudo-classes to arbitrary elements. You might decide to give users a “highlight” effect by way of the following:

```
body *:hover {background: yellow;}
```

This rule will cause any element that’s descended from the `body` element to

display a yellow background when it's in a hover state. Headings, paragraphs, lists, tables, images, and anything else found inside the `body` will be changed to have a yellow background. You could also change the font, put a border around the element being hovered, or alter anything else the browser will allow.

## Real-world issues with dynamic styling

Dynamic pseudo-classes present some interesting issues and peculiarities. For example, it's possible to set visited and unvisited links to one font size and make hovered links a larger size, as shown in [Figure 15-37](#):

```
a:link, a:visited {font-size: 13px;}  
a:hover, a:active {font-size: 20px;}
```



**Figure 15-37. Changing layout with dynamic pseudo-classes**

As you can see, the user agent increases the size of the anchor while the mouse pointer hovers over it, or, thanks to the `:active` setting, when a user touches it on a touch screen. A user agent that supports this behavior must redraw the document while an anchor is in hover state, which could force a reflow of all the content that follows the link.

# UI State Pseudo-Classes

Closely related to the dynamic pseudo-classes are the user interface (UI) state pseudo-classes, which are summarized in [Table 15-4](#). These pseudo-classes allow for styling based on the current state of user interface elements like checkboxes.

Table 15-4. UI state pseudo-classes

Name	Description
:enabled	Refers to user interface elements (such as form elements) that are enabled; that is, available for input.
:disabled	Refers to user interface elements (such as form elements) that are disabled; that is, not available for input.
:checked	Refers to radio buttons or checkboxes that have been selected, either by the user or by defaults within the document itself.
:indeterminate	Refers to radio buttons or checkboxes that are neither checked nor unchecked; this state can only be set via DOM scripting, and not due to user input.
:default	Refers to the radio button, checkbox or option that was selected by default.
:valid	Refers to a user-input that meets all of its data validity semantics

:invalid	Refers to a user-input that does not meet all of its data validity semantics
:in-range	Refers to a user-input whose value is between the minimum and maximum values
:out-of-range	Refers to a user-input whose value is below the minimum or above the maximum values allowed by the control
:required	Refers to a user-input that must have a value set
:optional	Refers to a user-input that does not need to have a value set
:read-write	Refers to a user-input that is editable by the user
:read-only	Refers to a user-input that is not editable by the user

Although the state of a UI element can certainly be changed by user action—e.g., a user checking or unchecking a checkbox—UI state pseudo-classes are not classified as purely dynamic because they can also be affected by the document structure or DOM scripting.

#### Note

You might think that `:focus` belongs in this section, not the previous section. However, the Selectors Level 3 specification groups `:focus` in with `:hover` and `:active`. This is most likely because they were grouped together in CSS2, which had no UI state pseudo-classes. More importantly, though, `focus` can be given to non-UI elements, such as headings or paragraphs—one example is when they are read by a speaking browser. That alone keeps it

from being considered a UI-state pseudo-class.

## Enabled and disabled UI elements

Thanks to both DOM scripting and HTML5, it is possible to mark a user interface element (or group of user interface elements) as being disabled. A disabled element is displayed, but cannot be selected, activated, or otherwise interacted with by the user. Authors can set an element to be disabled either through DOM scripting, or (in HTML5) by adding a `disabled` attribute to the element's markup.

Any element that hasn't been disabled is by definition enabled, and you can style these two states using `:enabled` and `:disabled`. It's much more common to simply style disabled elements and leave enabled elements alone, but both have their uses, as illustrated in [Figure 15-38](#).

```
:enabled {font-weight: bold;}  
:disabled {opacity: 0.5;}
```

<b>Name</b>	your full name
<b>Title</b>	your job title
<b>E-mail</b>	valid email only please

**Figure 15-38.** Styling enabled and disabled UI elements

## Check states

In addition to being enabled or disabled, certain UI elements can be checked or unchecked—in HTML, the input types “checkbox” and “radio” fit this definition. Selectors level 3 offers a `:checked` pseudo-class to handle elements in that state, though curiously it omits an `:unchecked`. There is also the `:indeterminate` pseudo-class, which matches any checkable UI element that is neither checked nor unchecked. These states are illustrated in [Figure 15-39](#).

```
:checked {background: silver;}
```

```
:indeterminate {border: red;}
```

In addition, you can use the negation pseudo-class, which is covered later, to select checkboxes which are not checked with

```
input[type="checkbox"] :not(:checked)
```

. Only radio buttons and checkboxes can be checked. All other elements, and these two when not checked, are :not(:checked)

**Rating**  1  2  3  4  5

**Figure 15-39.** Styling checked and indeterminate UI elements

Although checkable elements are unchecked by default, it's possible for a HTML author to toggle them on by adding the `checked` attribute to an element's markup. An author can also use DOM scripting to flip an element's checked state to checked or unchecked, whichever they prefer.

As we've seen, there is a third state, "indeterminate." As of mid-2015, this state can only be set through DOM scripting; there is no markup-level method to set elements to an indeterminate state. The purpose of allowing an indeterminate state is to visually indicate that the element needs to be checked (or unchecked) by the user. However, note that this is purely a visual effect: it does not affect the underlying state of the UI element, which is either checked or unchecked, depending on document markup and the effects of any DOM scripting.

#### Note

Although [Figure 15-39](#) does show styled radio buttons, styling of radio buttons and checkboxes with CSS is very limited. There aren't many CSS properties that apply to checkboxes and radio buttons, but that shouldn't limit your use of the selected-option pseudo-classes. Used in combination with the adjacent sibling selector, you can style the labels associated with your checkboxes and radio buttons:

```
<input id="chbx" type="checkbox"> <label for="chbx">I am a label<  
input[type="checkbox"] :checked + label {
```

```
color: red;  
font-style: italic;  
}
```

## Default Option pseudo-class

The `:default` pseudo-class matches the UI elements that are the default among a set of similar elements. Typically applies to context menu items, buttons and select lists/menus. If there are several same-named radio buttons, the one that was originally checked matches `:default`, even if the UI has been updated by the user so that it no longer matches `:checked`. If a checkbox was checked on page load, it would match. Any initially-selected `<option>`(s) in a `<select>` will match. The `:default` pseudo-class can also match buttons and menu items.

```
<input type="checkbox" id="chbx" checked name="foo" value="bar">  
[type="checkbox"] :default + label { font-style: italic; }
```

## Validity Pseudo-Classes

With the introduction of HTML5 web forms, there are new input types, many new attributes for the `<input>` element, and native validation. There are several newer UI pseudo-classes that match elements based on the current state of the user interface. Now form controls can be required to match a specific regular expression, can be of a specific data type. Numeric input types, including date and time input types, can be required to have a value, with the value being between a prescribed minimum and maximum value, and ever a value of a specific increment over the minimum value. The UI pseudo-classes target these form controls based on whether the value is currently valid or not, according to the constraints set by the element's attributes.

## Optionality Pseudo-classes

The optionality pseudo-class of `:required` matches any form control that is required, as denoted by the presence of the `required` attribute. The

`:optional` pseudo-class matches form controls that do not have the required attribute, or whose required attribute is set to false.

A form element is `:required` or `:optional` if a value for it is, respectively, required or optional before the form it belongs to can be validly submitted. Elements that are not form elements are neither required nor optional.

The `:required` pseudo-class refers to a user-input that must have a value set. The `:optional` pseudo-class refers to a user-input that does not need to have a value set.

```
<input type="email" placeholder="enter an email address" required>
<input type="email" placeholder="optional email address">

input:required { border: 1px solid #f00; }
input:optional { border: 1px solid #ccc; }
```

The first input will match the `:required` pseudo-class because of the presence of the required attribute. The second input is optional, and therefore will match the `:optional` pseudo-class.

We could have used attribute selectors instead. The selectors below are equivalent to the ones above:

```
input[required] { border: 1px solid #f00; }
input:not([required]) { border: 1px solid #ccc; }
```

## Validity Pseudo-Classes

The `:valid` pseudo-class refers to a user-input that meets all of its data validity semantics. The `:invalid` pseudo-class, on the other hand, refers to a user-input that does not meet all of its data validity semantics. The validity pseudo-classes: `:valid` and `:invalid`, only apply to elements having the capacity for data validity semantics: a `<div>` will never match either selector, but an `<input>` could match either, depending on the current state of the UI, even if no constraints were attached to that particular input.

```
<input type="tel" pattern="\d{3}-\d{3}-\d{4}" required>

input:focus:required {
```

```

background-position: 100% 50%;
background-repeat: no-repeat;
}
input:focus:required:invalid {
  background-image: url(warning.jpg);
}
input:focus:required:valid {
  background-image: url(checkmark.jpg);
}

```

In the above example, we style only required input types when they have focus with a warning icon when the value is not a valid value, and a checkmark when it is. By combining pseudo-classes, we improved usability: the document would be too busy with icons showing all the time. We only include icons when the user is interacting with the form control, letting them know via progressive enhancement when their value is valid.

## Range Pseudo-classes:

The range Pseudo-classes include `:in-range`, which refers to a user-input whose value is between the minimum and maximum values set by HTML5's `min` and `max` attributes, and `:out-of-range+`, which refers to a user-input whose value is below the minimum or above the maximum values allowed by the control.

```

<input id="nickels" type="number" min="0" max="1000" step="5" />

input:focus:out-of-range {
  background-image: url(warning.jpg);
}
input:focus:in-range {
  background-image: url(checkmark.jpg);
}

```

The `:in-range` and `:out-of-range` pseudo-classes apply only to elements with range limitations. Elements that don't have range limitations, like links for inputs of type `tel`, will match neither neither pseudo-class.

There is also a `step` attribute in HTML5. If the value is invalid because it does not match the step, but is still between or equal to the `min` and `max` values, it will match `:invalid`, but it is still `:in-range`.

## Mutability Pseudo-classes

The mutability pseudo-classes include `:read-write`, which refers to a user-input that is editable by the user, and `:read-only`, matching user-inputs that are not editable. Only elements that have the capacity to be alterable can match `:read-write`. For example, in HTML, a non-disabled, non-`readonly` `<input>` element is `:read-write`, as is any element with the `+contenteditable` attribute. Everything else, including the `body`, as long as it is not `contenteditable`, matches `:read-only`.

```
input:read-only { opacity: 0.75; }
pre:read-write:hover { border: 1px dashed green; }
```

# The :target Pseudo-Class

When a URL includes a fragment identifier, the piece of the document at which it points is called (in CSS) the *target*. Thus you can uniquely style any element that is the target of a URL fragment identifier with the `:target` pseudo-class.

Even if you’re unfamiliar with the term “fragment identifier,” you’ve almost certainly seen them in action. Consider this URL:

`http://www.w3.org/TR/css3-selectors/#target-pseudo`

The `target-pseudo` portion of the URL is the fragment identifier, which is marked by the `#` symbol. If the referenced page (<http://www.w3.org/TR/css3-selectors/>) has an element with an ID of `target-pseudo`, then that element becomes the target of the fragment identifier.

Thanks to `:target`, you can highlight any targeted element within a document, or you can devise different styles for various types of elements that might be targeted—say, one style for targeted headings, another for targeted tables, and so on. [Figure 15-40](#) shows an example of `:target` in action:

```
*:target {border-left: 5px solid gray; background: yellow url(tar  
top right no-repeat;}
```

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(Text courtesy <http://andrewdavidson.com/gibberish/>)

**Figure 15-40. Styling a fragment identifier target**

Somewhat obviously, `:target` styles will not be applied in two circumstances:

1. If the page is accessed via a URL that does not have a fragment identifier.
2. If the page is accessed via a URL that has a fragment identifier, but the identifier does not match any elements within the document.

More interestingly, though, what happens if multiple elements within a document can be matched by the fragment identifier—for example, if the author erroneously included three separate instances of `<div id="target-pseudo">` in the same document?

The short answer is that CSS doesn’t have or need rules to cover this case, because all CSS is concerned with styling targets. Whether the browser picks just one of the three elements to be the target or designates all three as co-equal targets, `:target` styles should be applied to anything that is a target.

# The :lang Pseudo-Class

For situations where you want to select an element based on its language, you can use the `:lang()` pseudo-class. In terms of its matching patterns, the `:lang()` pseudo-class is similar to the `|=` attribute selector. For example, to italicize elements whose content is written in French, you could write either of the following:

```
*:lang(fr) {font-style: italic;}  
*[lang|="fr"] {font-style: italic;}
```

The primary difference between the pseudo-class selector and the attribute selector is that language information can be derived from a number of sources, some of which are outside the element itself. For the attribute selector, the element must have `ht`e attribute present to match. The `:lang` pseudo-class, however, matches descendants of an element with the language declaration. As Selectors Level 3 states:

...in HTML, the language is determined by a combination of the `lang` attribute, and possibly information from the `meta` elements and the protocol (such as HTTP headers). XML uses an attribute called `xml:lang`, and there may be other document language-specific methods for determining the language.

The pseudo-class will operate on all of that information, whereas the attribute selector can only work if there is a `lang` attribute present in the element's markup. Therefore, the pseudo-class is more robust than the attribute selector and is probably a better choice in most cases where language-specific styling is needed.

# The Negation Pseudo-Class

Every selector we've covered thus far has had one thing in common: they're all positive selectors. In other words, they are used to identify the things that should be selected, thus excluding by implication all the things that don't match and are thus not selected.

For those times when you want to invert this formulation and select elements based on what they are *not*, Selectors Level 3 introduced the negation pseudo-class, `:not()`. It's not quite like any other selector, fittingly enough, and it does have some restrictions on its use, but let's start with an example.

Let's suppose you want to apply a style to every list item that doesn't have a class of `moreinfo`, as illustrated in [Figure 15-41](#). That used to be very difficult, and in certain cases impossible, to make happen. If we wanted all the list items to be italic except those with the class `.moreinfo`, we used to declare all the links as italic, generally having to target the `ul` with a class, then normalize back based on the class, making sure the override came last in the source order, and had equal or higher specificity. Now we can simply declare:

```
li:not(.moreinfo) {font-style: italic;}
```

These are the necessary steps:

- *Insert key*
- *Turn key clockwise*
- [Grip steering wheel with hands](#)
- [Push accelerator](#)
- *Steer vehicle*
- [Use brake as necessary](#)

Do *not* push the brake at the same time as the accelerator.

**Figure 15-41.** Styling list items that don't have a certain class

The way `:not()` works is that you attach it to an element, and then in the

parentheses you fill in a simple selector. A simple selector, according to the W3C, is:

...either a type selector, universal selector, attribute selector, class selector, ID selector, or pseudo-class.

Basically, a simple selector is a selector with no ancestral / descendant relationship.

Note the “either” there: you can only use one of those inside `:not()`. You can’t group them and you can’t combine them using combinators, which means you can’t use a descendant selector, because the space separating elements in a descendant selector is a combinator. Those restrictions may (indeed most likely will) be lifted in a post-Level 3 specification, but we can still do quite a lot even within the given constraints.

For example, let’s flip around the previous example and select all elements with a `class` of `moreinfo` that are not list items. This is illustrated in [Figure 15-42](#).

```
.moreinfo:not(li) {font-style: italic;}
```

These are the necessary steps:

- Insert key
- Turn key **clockwise**
- [Grip steering wheel with hands](#)

Do *not* push the brake at the same time as the accelerator. Doing so can cause what [computer scientists](#) might term a “[race condition](#)” except you won’t be racing so much as burning out the engine. This can cause a fire, lead to [a traffic accident](#), or worse.

[Figure 15-42. Styling elements with a certain class that aren’t list items](#)

Translated into English, the selector would say, “Select all elements with a `class` whose value contains the word `moreinfo` as long as they are not `li` elements.” Similarly, the translation of `li:not(.moreinfo)` would be “Select all `li` elements as long as they do not have a `class` whose value contains the word `moreinfo`.”

Technically, you can put a universal selector into the parentheses, but there's very little point. After all, `p:not(*)` would mean “Select any `p` element as long as it isn't any element” and there's no such thing as an element that is not an element. Very similar to that would be `p:not(p)`, which would also select nothing. It's also possible to write things like `p:not(div)`, which will select any `p` element that is not a `div` element—in other words, all of them. Again, there is very little reason to do so.

You can also use the negation pseudo-class at any point in a more complex selector. Thus to select all tables that are not children of a `section` element, you would write `*:not(section) > table`. Similarly, to select table header cells that are not part of the table header, you'd write something like `table *:not(thead) > tr > th`, with a result like that shown in [Figure 15-43](#).

State	Post	Capital	State Bird
Alabama	AL	Montgomery	Yellowhammer
Alaska	AK	Juneau	Willow Ptarmigan
Arizona	AZ	Phoenix	Cactus Wren
Arkansas	AR	Little Rock	Mockingbird
California	CA	Sacramento	California Quail
Colorado	CO	Denver	Lark Bunting
Connecticut	CT	Hartford	American Robin
Delaware	DE	Dover	Blue Hen Chicken
Florida	FL	Tallahassee	Northern Mockingbird
Georgia	GA	Atlanta	Brown Thrasher
State	Post	Capital	State Bird

**Figure 15-43.** Styling table cells that aren't in the table's header

What you cannot do is nest negation pseudo-classes; thus, `p:not(:not(p))` is invalid and will be ignored. It's also, logically, the equivalent of simply writing `p`, so there's no point anyway. Furthermore, you cannot reference pseudo-elements (which we'll cover shortly) inside the parentheses, since they are not simple selectors.

On the other hand, it's possible to chain negations together to create a sort of “and also not this” effect. For example, you might want to select all elements with a class of `link` that are neither list items nor paragraphs.

```
*.link:not(li):not(p) {font-style: italic;}
```

That translates to “Select all elements with a `class` whose value contains the word `link` as long as they are neither `li` nor `p` elements.”

One thing to watch out for is that you can have situations where rules combine in unexpected ways, mostly because we’re not used to thinking of selection in the negative. Consider this very simple test case:

```
div:not(.one) p {font-weight: normal;}  
div.one p {font-weight: bold;}  
  
<div class="one">  
  <div class="two">  
    <p>I'm a paragraph!</p>  
  </div>  
</div>
```

The paragraph will be boldfaced, not normal-weight. This is because both rules match: the `p` element is descended from a `div` whose `class` does not contain the word `one` (`<div class="two">`), but it is *also* descended from a `div` whose `class` contains the word `one`. Both rules match, and so both apply. Since there is a conflict, the cascade is used to resolve the conflict, and the second rule wins. The structural arrangement of the markup, with the `div.two` being “closer” to the paragraph than `div.one`, is irrelevant.

#### Note

An interesting aspect of the negation pseudo-class is that it, like the universal selector, does not count towards specificity, but the selector passed as the parameter does. We cover specificity later in the book.

# Pseudo-Element Selectors

Much as pseudo-classes assign phantom classes to anchors, pseudo-elements insert fictional elements into a document in order to achieve certain effects. Four pseudo-elements are defined in CSS, and they let you style the first letter of an element, style the first line of an element, and both create and style “before” and “after” content.

Unlike the single colon of pseudo-classes, pseudo-elements employ a double-colon syntax, like `::first-line`. This is meant to distinguish pseudo-elements from pseudo-classes. This was not always the case—in CSS2, both selector types used a single colon—so for backwards compatibility, browsers will accept single-colon pseudo-element selectors. Don’t take this as an excuse to be sloppy, though! Use the proper number of colons at all times in order to future-proof your CSS; after all, there is no way to predict when browsers will stop accepting single-colon pseudo-element selectors.

Note that all pseudo-elements must be placed at the very end of the selector in which they appear. Therefore, it would not be legal to write `p::first-line em` since the pseudo-element comes before the subject of the selector (the subject is the last element listed). This also means that only one pseudo-element is permitted in a given selector, though that restriction may be eased in future versions of CSS.

# Styling the First Letter

The first pseudo-element styles the first letter, or punctuation characters and the first letter if the text starts with punctuation, of any non-inline element.

```
p::first-letter {color: red;}
```

This rule causes the first letter of every paragraph to be colored red. The ::first-letter pseudo-element is most commonly used to create an “initial cap” or “drop cap” typographic effect. You could make the first letter of each `p` twice as big as the rest of the heading, though you may want to only apply this styling to the first letter of the first paragraph:

```
p:first-of-type::first-letter {font-size: 200%;}
```

The result of this rule is illustrated in [Figure 15-44](#).



This is an h2 element

Figure 15-44. The ::first-letter pseudo-element in action

As mentioned, this rule effectively causes the user agent to respond to a fictional, or “faux” element, that encloses the first letter of each `p`. It would look something like this:

```
<p><p-first-letter>T</p-first-letter>his is a p element, with a
```

The ::first-letter styles are applied only to the contents of the fictional element shown in the example. This `<p-first-letter>` element does *not* appear in the document source, nor even in the DOM tree. Instead, its existence is constructed on the fly by the user agent and is used to apply the ::first-letter style(s) to the appropriate bit of text. In other words, `<p-first-letter>` is a pseudo-element. Remember, you don’t have to add any

new tags. The user agent style the first letter for you as if you had encased it in a styled element.

The first-letter is defined as the first typographic letter unit of the originating element, if it is not preceded by other, like an image. The specifications use “letter unit” because some languages have letters made up of more than character, like “oe” in Norse. Punctuation that precede or follow the first letter unit, even if there are several of them, are included in the ::first-letter pseudo-element.

# Styling the First Line

Similarly, `::first-line` can be used to affect the first line of text in an element. For example, you could make the first line of each paragraph in a document large and purple:

```
p::first-line {  
    font-size: 150%;  
    color: purple;  
}
```

In [Figure 15-45](#), the style is applied to the first displayed line of text in each paragraph. This is true no matter how wide or narrow the display region is. If the first line contains only the first five words of the paragraph, then only those five words will be big and purple. If the first line contains the first 30 words of the element, then all 30 will be big and purple.

This is a paragraph of text which has only  
one stylesheet applied to it. That style  
causes the first line to be gray. No other  
lines will be gray.

**Figure 15-45.** The `::first-line` pseudo-element in action

Because the text from “This” to “only” should be big and purple, the user agent employs a fictional markup that looks something like this:

```
<p><p-first-line>This is a paragraph of text that has only</p-fir  
one stylesheet applied to it. That style  
causes the first line to be big and purple.  
No other line will inherit the styles from...</p>
```

If the first line of text were edited to include only the first seven words of the paragraph, then the fictional `</p-first-line>` would move back and occur just after the word “that.” If the user were to increase or decrease the font-size rendering, or expand or contract the browser window causing the width of the text to change, thereby causing the number of words on the first line to increase or decrease, the browser automatically sets only the words in the

currently displayed first line to be both big and purple.

The length of the first line depends on a number of factors, including the font-size, letter spacing, width of the parent container, etc. Depending on the markup, and the length of that first line, it is possible that the end of the first line comes in the middle of a nested element. If the ::first-line breaks up a nested element, such as an `em` or a link, the properties attached to the ::first-line will only apply to the portion of that nested element that is displayed on the first line.

# Restrictions on ::first-letter and ::first-line

The `::first-letter` and `::first-line` pseudo-elements currently can be applied only to block-display elements such as headings or paragraphs and not to inline-display elements such as hyperlinks. There are also limits on the CSS properties that may be applied to `::first-line` and `::first-letter`. [Table 15-5](#) displays the limits.

The faux `::first-line` and `first-letter` pseudo-elements that are implemented but not really created, are similar to an inline-level span around that first line and first letter respectively that can be styled, but have limited CSS properties that can be applied to them.

Table 15-5. Properties permitted on pseudo-elements  
`::first-letter`                           `::first-line`

All font properties	All font properties
<code>color</code> and <code>opacity</code>	<code>color</code>
All background properties	All background properties
All margin properties	<code>word-spacing</code>
All padding properties	<code>letter-spacing</code>
All border properties	<code>text-decoration</code>
<code>text-decoration</code>	<code>vertical-align</code>

box-shadow

inline typesetting properties

all text decoration properties

vertical-align (if float is set to none)

text-transform

text-transform

line-height

line-height

clear (CSS2 only; removed in CSS2.1)

float

letter-spacing (added in CSS2.1)

word-spacing (added in CSS2.1)

clear (CSS2 only; removed in CSS2.1)

# Styling (Or Creating) Content Before and After Elements

Let's say you want to preface every `h2` element with a pair of silver square brackets as a typographical effect:

```
h2::before {content: "[]"; color: silver;}
```

CSS2.1 lets you insert *generated content*, and then style it directly using the pseudo-elements `::before` and `::after`. [Figure 15-46](#) illustrates an example.

 **This is an h2 element**

**Figure 15-46. Inserting content before an element**

The pseudo-element is used to insert the generated content and to style it. To place content after an element, use the pseudo-element `::after`. You could end your documents with an appropriate finish:

```
body::after {content: "The End.";}
```

Generated content is a separate subject, and the entire topic (including more detail on `::before` and `::after`) is covered more thoroughly in just a bit.

# Summary

By using selectors based on the document's language, authors can create CSS rules that apply to a large number of similar elements just as easily as they can construct rules that apply in very narrow circumstances. The ability to group together both selectors and rules keeps style sheets compact and flexible, which incidentally leads to smaller file sizes and faster download times.

Selectors are the one thing that user agents usually must get right because the inability to correctly interpret selectors pretty much prevents a user agent from using CSS at all. On the flip side, it's crucial for authors to correctly write selectors because errors can prevent the user agent from applying the styles as intended. An integral part of correctly understanding selectors and how they can be combined is a strong grasp of how selectors relate to document structure and how mechanisms—such as inheritance and the cascade itself—come into play when determining how an element will be styled.

# Chapter 16. Specificity and the Cascade

[Chapter 15](#) showed how document structure and CSS selectors allow you to apply a wide variety of styles to elements. Knowing that every valid document generates a structural tree, you can create selectors that target elements based on their ancestors, attributes, sibling elements, and more. The structural tree is what allows selectors to function and is also central to a similarly crucial aspect of CSS: inheritance.

*Inheritance* is the mechanism by which some property values are passed on from an element to its descendants. When determining which values should apply to an element, a user agent must consider not only inheritance but also the *specificity* of the declarations, as well as the origin of the declarations themselves. This process of consideration is what's known as the *cascade*. We will explore the interrelation between these three mechanisms—specificity, inheritance, and the cascade—in this chapter, but the difference between the latter two can be summed up this way: choosing the result of `h1 {color: red; color: blue;}` is the cascade; making a `span` inside the `h1` blue is inheritance.

Above all, regardless of how abstract things may seem, keep going! Your perseverance will be rewarded.

# Specificity

You know from [Chapter 15](#) that you can select elements using a wide variety of means. In fact, it's possible that the same element could be selected by two or more rules, each with its own selector. Let's consider the following three pairs of rules. Assume that each pair will match the same element:

```
h1 {color: red;}  
body h1 {color: green;}  
  
h2.grape {color: purple;}  
h2 {color: silver;}  
  
html > body table tr[id="totals"] td ul > li {color: maroon;}  
li#answer {color: navy;}
```

Obviously, only one of the two rules in each pair can win out, since the matched elements can be only one color or the other. How do you know which one will win?

The answer is found in the *specificity* of each selector. For every rule, the user agent evaluates the specificity of the selector and attaches it to each declaration in the rule. When an element has two or more conflicting property declarations, the one with the highest specificity will win out.

## Note

This isn't the whole story in terms of conflict resolution. All style conflict resolution (including specificity) is handled by the cascade, which has its own section later in this chapter.

A selector's specificity is determined by the components of the selector itself. A specificity value can be expressed in four parts, like this:  $0, 0, 0, 0$ . The actual specificity of a selector is determined as follows:

- For every ID attribute value given in the selector, add  $0, 1, 0, 0$ .

- For every class attribute value, attribute selection, or pseudo-class given in the selector, add  $0, 0, 1, 0$ .
- For every element and pseudo-element given in the selector, add  $0, 0, 0, 1$ . CSS2 contradicted itself as to whether pseudo-elements had any specificity at all, but CSS2.1 made it clear that they do, and this is where they belong.
- Combinators and the universal selector do not contribute anything to the specificity (more on these values later).

For example, the following rules' selectors result in the indicated specificities:

```

h1 {color: red;}                      /* specificity = 0,0,0,1 */
p em {color: purple;}                 /* specificity = 0,0,0,2 */
.grape {color: purple;}                /* specificity = 0,0,1,0 */
*.bright {color: yellow;}              /* specificity = 0,0,1,0 */
p.bright em.dark {color: maroon;}     /* specificity = 0,0,2,2 */
#id216 {color: blue;}                 /* specificity = 0,1,0,0 */
div#sidebar *[href] {color: silver;}  /* specificity = 0,1,1,1 */

```

Given a case where an `em` element is matched by both the second and fifth rules in the example above, that element will be maroon because the fifth rule's specificity outweighs the second's.

As an exercise, let's return to the pairs of rules from earlier in the section and fill in the specificities:

```

h1 {color: red;}          /* 0,0,0,1 */
body h1 {color: green;}  /* 0,0,0,2 (winner) */

h2.grape {color: purple;} /* 0,0,1,1 (winner) */
h2 {color: silver;}      /* 0,0,0,1 */

html > body table tr[id="totals"] td ul > li {color: maroon;}  /*
li#answer {color: navy;}   /*

```

I've indicated the winning rule in each pair; in each case, it's because the specificity is higher. Notice how they're sorted. In the second pair, the selector `h2.grape` wins because it has an extra 1:  $0, 0, 1, 1$  beats out  $0, 0, 0, 1$ .

In the third pair, the second rule wins because  $0, 1, 0, 1$  wins out over  $0, 0, 1, 7$ . In fact, the specificity value  $0, 0, 1, 0$  will win out over the value  $0, 0, 0, 13$ .

This happens because the values are sorted from left to right. A specificity of  $1, 0, 0, 0$  will win out over any specificity that begins with a  $0$ , no matter what the rest of the numbers might be. So  $0, 1, 0, 1$  wins over  $0, 0, 1, 7$  because the  $1$  in the first value's second position beats out the  $0$  in the second value's second position.

# Declarations and Specificity

Once the specificity of a selector has been determined, the specificity value will be conferred on all of its associated declarations. Consider this rule:

```
h1 {color: silver; background: black;}
```

For specificity purposes, the user agent must treat the rule as if it were “ungrouped” into separate rules. Thus, the previous example would become:

```
h1 {color: silver;}  
h1 {background: black;}
```

Both have a specificity of  $0, 0, 0, 1$ , and that’s the value conferred on each declaration. The same splitting-up process happens with a grouped selector as well. Given the rule:

```
h1, h2.section {color: silver; background: black;}
```

...the user agent treats it as if it were the following:

```
h1 {color: silver;} /* 0,0,0,1 */  
h1 {background: black;} /* 0,0,0,1 */  
h2.section {color: silver;} /* 0,0,1,1 */  
h2.section {background: black;} /* 0,0,1,1 */
```

This becomes important in situations where multiple rules match the same element and some of the declarations clash. For example, consider these rules:

```
h1 + p {color: black; font-style: italic;} /* 0,0,0,  
p {color: gray; background: white; font-style: normal;} /* 0,0,0,  
*.aside {color: black; background: silver;} /* 0,0,1,
```

When applied to the following markup, the content will be rendered as shown in [Figure 16-1](#):

```
<h1>Greetings!</h1>  
<p class="aside">
```

```
It's a fine way to start a day, don't you think?  
</p>  
<p>  
There are many ways to greet a person, but the words are not as important as the act of greeting itself.  
</p>  
<h1>Salutations!</h1>  
<p>  
There is nothing finer than a hearty welcome from one's fellow man.  
</p>  
<p class="aside">  
Although a thick and juicy hamburger with bacon and mushrooms runs a close second.  
</p>
```

## Greetings!

*It's a fine way to start a day, don't you think?*

There are many ways to greet a person, but the words are not so important as the act of greeting itself.

## Salutations!

*There is nothing finer than a hearty welcome from one's fellow man.*

*Although a thick and juicy hamburger with bacon and mushrooms runs a close second.*

**Figure 16-1. How different rules affect a document**

In every case, the user agent determines which rules match a given element, calculates all of the associated declarations and their specificities, determines which rules win out, and then applies the winners to the element to get the styled result. These machinations must be performed on every element, selector, and declaration. Fortunately, the user agent does it all automatically. This behavior is an important component of the cascade, which we will discuss later in this chapter.

# Universal Selector Specificity

As mentioned earlier, the universal selector does not contribute to specificity. In other words, it has a specificity of  $0, 0, 0, 0$ , which is different than having no specificity (as we'll discuss in "Inheritance"). Therefore, given the following two rules, a paragraph descended from a `div` will be black, but all other elements will be gray:

```
div p {color: black;} /* 0,0,0,2 */
* {color: gray;}      /* 0,0,0,0 */
```

As you might expect, this means that the specificity of a selector that contains a universal selector along with other selectors is not changed by the presence of the universal selector. The following two selectors have exactly the same specificity:

```
div p          /* 0,0,0,2 */
body * strong /* 0,0,0,2 */
```

Combinators, by comparison, have no specificity at all—not even zero specificity. Thus, they have no impact on a selector's overall specificity.

# ID and Attribute Selector Specificity

It's important to note the difference in specificity between an ID selector and an attribute selector that targets an `id` attribute. Returning to the third pair of rules in the example code, we find:

```
html > body table tr[id="totals"] td ul > li {color: maroon;} /*  
li#answer {color: navy;} */
```

The ID selector (`#answer`) in the second rule contributes  $0, 1, 0, 0$  to the overall specificity of the selector. In the first rule, however, the attribute selector (`[id="totals"]`) contributes  $0, 0, 1, 0$  to the overall specificity. Thus, given the following rules, the element with an `id` of `meadow` will be green:

```
#meadow {color: green;}      /* 0,1,0,0 */  
*[id="meadow"] {color: red;} /* 0,0,1,0 */
```

# Inline Style Specificity

So far, we've only seen specificities that begin with a zero, so you may be wondering why it's there at all. As it happens, that first zero is reserved for inline style declarations, which trump any other declaration's specificity. Consider the following rule and markup fragment:

```
h1 {color: red;}  
  
<h1 style="color: green;">The Meadow Party</h1>
```

Given that the rule is applied to the `h1` element, you would still probably expect the text of the `h1` to be green. This happens because every inline declaration has a specificity of  $1, 0, 0, 0$ .

This means that even elements with `id` attributes that match a rule will obey the inline style declaration. Let's modify the previous example to include an `id`:

```
h1#meadow {color: red;}  
  
<h1 id="meadow" style="color: green;">The Meadow Party</h1>
```

Thanks to the inline declaration's specificity, the text of the `h1` element will still be green.

# Importance

Sometimes, a declaration is so important that it outweighs all other considerations. CSS calls these *important declarations* (for obvious reasons) and lets you mark them by inserting `!important` just before the terminating semicolon in a declaration:

```
p.dark {color: #333 !important; background: white;}
```

Here, the color value of `#333` is marked `!important`, whereas the background value of `white` is not. If you wish to mark both declarations as important, each declaration will need its own `!important` marker:

```
p.dark {color: #333 !important; background: white !important;}
```

You must place `!important` correctly, or the declaration may be invalidated. `!important` *always* goes at the end of the declaration, just before the semicolon. This placement is especially important—no pun intended—when it comes to properties that allow values containing multiple keywords, such as `font`:

```
p.light {color: yellow; font: smaller Times, serif !important;}
```

If `!important` were placed anywhere else in the `font` declaration, the entire declaration would likely be invalidated and none of its styles applied.

I realize that to those of you who come from a programming background, the syntax of this token instinctively translates to “not important.” For whatever reason, the bang (!) was chosen as the delimiter for important tokens, and it does *not* mean “not” in CSS, no matter how many other languages give it that very meaning. This association is unfortunate, but we’re stuck with it.

Declarations that are marked `!important` do not have a special specificity value, but are instead considered separately from non-important declarations. In effect, all `!important` declarations are grouped together, and specificity conflicts are resolved relatively within that group. Similarly, all non-important declarations are considered together, with any conflicts within the

non-important group are resolved using specificity. Thus, in any case where an important and a non-important declaration conflict, the important declaration *always* wins.

[Figure 16-2](#) illustrates the result of the following rules and markup fragment:

```
h1 {font-style: italic; color: gray !important;}  
.title {color: black; background: silver;}  
* {background: black !important;}  
  
<h1 class="title">NightWing</h1>
```



**Figure 16-2. Important rules always win**

**Note**

Important declarations and their handling are discussed in more detail in “The Cascade” later in this chapter.

# Inheritance

As important as specificity may be to understanding how declarations are applied to a document, another key concept is *inheritance*. Inheritance is the mechanism by which styles are applied not only to a specified element, but also to its descendants. If a color is applied to an `h1` element, for example, then that color is applied to all text inside the `h1`, even the text enclosed within child elements of that `h1`:

```
h1 {color: gray;}  
  
<h1>Meerkat <em>Central</em></h1>
```

Both the ordinary `h1` text and the `em` text are colored gray because the `em` element inherits the value of `color` from the `h1`. If property values could not be inherited by descendant elements, the `em` text would be black, not gray, and you'd have to color the elements separately.

Consider an unordered list. Let's say you apply a style of `color: gray;` for `ul` elements:

```
ul {color: gray;}
```

You expect that style applied to a `ul` will also be applied to its list items, and also to any content of those list items. Thanks to inheritance, that's exactly what happens, as [Figure 16-3](#) demonstrates.

- Oh, don't you wish
  - That you could be a fish
  - And swim along with me
  - Underneath the sea
1. Strap on some fins
  2. Adjust your mask
  3. Dive in!

**Figure 16-3.** Inheritance of styles

It's easier to see how inheritance works by turning to a tree diagram of a document. [Figure 16-4](#) shows the tree diagram for a very simple document containing two lists: one unordered and the other ordered.

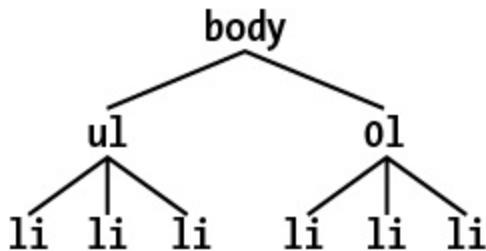


Figure 16-4. A simple tree diagram

When the declaration `color: gray;` is applied to the `ul` element, that element takes on that declaration. The value is then propagated down the tree to the descendant elements and continues on until there are no more descendants to inherit the value. Values are *never* propagated upward; that is, an element never passes values up to its ancestors.

**Note**

There is an exception to the upward propagation rule in HTML: background styles applied to the `body` element can be passed to the `html` element, which is the document's root element and therefore defines its canvas. This only happens if the `body` element has a defined background and the `html` element does not.

Inheritance is one of those things about CSS that is so basic that you almost never think about it unless you have to. However, you should still keep a couple of things in mind.

First, note that many properties are not inherited—generally as a result of simple common sense. For example, the property `border` (which is used to set borders on elements) does not inherit. A quick glance at [Figure 16-5](#) reveals why this is the case. If borders were inherited, documents would become much more cluttered—unless the author took the extra effort to turn off the inherited borders.

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**Figure 16-5.** Why borders aren't inherited

As it happens, most of the box-model properties—including margins, padding, backgrounds, and borders—are not inherited for the same reason. After all, you wouldn't want all of the links in a paragraph to inherit a 30-pixel left margin from their parent element!

Second, inherited values have no specificity at all, not even zero specificity. This seems like an academic distinction until you work through the consequences of the lack of inherited specificity. Consider the following rules and markup fragment and compare them to the result shown in [Figure 16-6](#):

```
* {color: gray;}  
h1#page-title {color: black;}  
  
<h1 id="page-title">Meerkat <em>Central</em></h1>  
<p>  
Welcome to the best place on the web for meerkat information!  
</p>
```

## Meerkat *Central*

Welcome to the best place on the Web for meerkat information!

**Figure 16-6.** Zero specificity defeats no specificity

Since the universal selector applies to all elements and has zero specificity, its color declaration's value of `gray` wins out over the inherited value of `black`, which has no specificity at all. Therefore, the `em` element is rendered `gray` instead of `black`.

This example vividly illustrates one of the potential problems of using the universal selector indiscriminately. Because it can match *any* element, the

universal selector often has the effect of short-circuiting inheritance. This can be worked around, but it's usually more sensible to avoid the problem in the first place by not using the universal selector indiscriminately.

The complete lack of specificity for inherited values is not a trivial point. For example, assume that a style sheet has been written such that all text in a “toolbar” is to be white on black:

```
#toolbar {color: white; background: black;}
```

This will work so long as the element with an `id` of `toolbar` contains nothing but plain text. If, however, the text within this element is all hyperlinks (`a` elements), then the user agent's styles for hyperlinks will take over. In a web browser, this means they'll likely be colored blue, since the browser's internal style sheet probably contains an entry like this:

```
a:link {color: blue;}
```

To overcome this problem, you must declare something like this:

```
#toolbar {color: white; background: black;}  
#toolbar a:link {color: white;}
```

By targeting a rule directly at the `a` elements within the toolbar, you'll get the result shown in [Figure 16-7](#).



```
Home | Products | Services | Contact | About
```

**Figure 16-7. Directly assigning styles to the relevant elements**

Another way to get the same result is to use the value `inherit`, covered in the previous chapter. We can alter the previous example like so:

```
#toolbar {color: white; background: black;}  
#toolbar a:link {color: inherit;}
```

This also leads to the result shown in [Figure 16-7](#), because the value of `color` is explicitly inherited thanks to an assigned rule whose selector has specificity.

# The Cascade

Throughout this chapter, we've skirted one rather important issue: what happens when two rules of equal specificity apply to the same element? How does the browser resolve the conflict? For example, say you have the following rules:

```
h1 {color: red;}  
h1 {color: blue;}
```

Which one wins? Both have a specificity of  $0, 0, 0, 1$ , so they have equal weight and should both apply. That simply can't be the case because the element can't be both red and blue. So which will it be?

At last, the name “Cascading Style Sheets” makes sense: CSS is based on a method of causing styles to *cascade* together, which is made possible by combining inheritance and specificity with a few rules. The cascade rules for CSS are simple enough:

1. Find all rules that contain a selector that matches a given element.
2. Sort all declarations applying to the given element by **explicit weight**. Those rules marked `!important` have a higher weight than those that are not.
3. Sort all declarations applying to the given element by **origin**. There are three basic origins: author, reader, and user agent. Under normal circumstances, the author's styles win out over the reader's styles. `!important` reader styles are stronger than any other styles, including `!important` author styles. Both author and reader styles override the user agent's default styles.
4. Sort all declarations applying to the given element by **specificity**. Those elements with a higher specificity have more weight than those with lower specificity.

5. Sort all declarations applying to the given element by **order**. The later a declaration appears in the style sheet or document, the more weight it is given. Declarations that appear in an imported style sheet are considered to come before all declarations within the style sheet that imports them.

To be perfectly clear about how this all works, let's consider some examples that illustrate the last four of the five cascade rules. (The first rule is kind of obvious, so we're skipping right past it.)

**Note**

Some later CSS modules add more origins to the basic list of three; for example, the animation and transition origins. These are not covered here, but are addressed in the chapters on those topics.

# Sorting by Weight and Origin

If two rules apply to an element, and one is marked `!important`, the important rule wins out:

```
p {color: gray !important;}  
  
<p style="color: black;">Well, <em>hello</em> there!</p>
```

Despite the fact that there is a color assigned in the `style` attribute of the paragraph, the `!important` rule wins out, and the paragraph is gray. This gray is inherited by the `em` element as well.

Note that if an `!important` is added to the inline style, then *it* will be the winner. Thus, given the following, the paragraph (and its descendant element) will be black:

```
p {color: gray !important;}  
  
<p style="color: black !important;">Well, <em>hello</em> there!</
```

In situations where the explicit weight is the same, the origin of a rule is considered. If an element is matched by normal-weight styles in both the author's style sheet and the reader's style sheet, then the author's styles are used. For example, assume that the following styles come from the indicated origins:

```
p em {color: black;}      /* author's style sheet */  
  
p em {color: yellow;}    /* reader's style sheet */
```

In this case, emphasized text within paragraphs is colored black, not yellow, because normal-weight author styles win out over normal-weight reader styles. However, if both rules are marked `!important`, the situation changes:

```
p em {color: black !important;}    /* author's style sheet */  
  
p em {color: yellow !important;}   /* reader's style sheet */
```

Now the emphasized text in paragraphs will be yellow, not black.

As it happens, the user agent's default styles—which are often influenced by the user preferences—are figured into this step. The default style declarations are the least influential of all. Therefore, if an author-defined rule applies to anchors (e.g., declaring them to be `white`), then this rule overrides the user agent's defaults.

To sum up, there are five basic levels to consider in terms of declaration weight. In order of most to least weight, these are:

1. Reader important declarations
2. Author important declarations
3. Author normal declarations
4. Reader normal declarations
5. User agent declarations

Authors typically need to worry about only the first four weight levels, since anything declared by an author will win out over the user agent's styles.

# Sorting by Specificity

If conflicting declarations apply to an element and they all have the same explicit weight and origin, they should be sorted by specificity, with the most specific declaration winning out. For example:

```
p#bright {color: silver;}  
p {color: black;}  
  
<p id="bright">Well, hello there!</p>
```

Given the rules shown, the text of the paragraph will be silver, as illustrated in [Figure 16-8](#). Why? Because the specificity of `p#bright (0, 1, 0, 1)` overrode the specificity of `p (0, 0, 0, 1)`, even though the latter rule comes later in the style sheet.

Well, hello there!

**Figure 16-8. Higher specificity wins out over lower specificity**

# Sorting by Order

Finally, if two rules have exactly the same explicit weight, origin, and specificity, then the one that occurs later in the style sheet wins out. Let's return to our earlier example, where we find the following two rules in the document's style sheet:

```
h1 {color: red;}  
h1 {color: blue;}
```

In this case, the value of `color` for all `h1` elements in the document will be `blue`, not `red`. This is because the two rules are tied in terms of explicit weight and origin, and the selectors have equal specificity, so the last one declared is the winner.

So what happens if rules from completely separate style sheets conflict? For example, suppose the following:

```
@import url(basic.css);  
h1 {color: blue;}
```

What if `h1 {color: red;}` appears in `basic.css`? The entire contents of `basic.css` are treated as if they were pasted into the style sheet at the point where the `@import` occurs. Thus, any rule contained in the document's style sheet occurs later than those from the `@import`. If they tie in terms of explicit weight and specificity, the document's style sheet contains the winner. Consider the following:

```
p em {color: purple;} /* from imported style sheet */  
p em {color: gray;} /* rule contained within the document */
```

In this case, the second rule shown wins out over the imported rule because it was the last one specified.

Order sorting is the reason behind the often-recommended ordering of link styles. The recommendation is that you array your link styles in the order link-visited-focus-hover-active, or LVFHA, like this:

```
a:link {color: blue;}  
a:visited {color: purple;}  
a:focus {color: green;}  
a:hover {color: red;}  
a:active {color: orange;}
```

Thanks to the information in this chapter, you now know that the specificity of all of these selectors is the same:  $0, 0, 1, 0$ . Because they all have the same explicit weight, origin, and specificity, the last one that matches an element will win out. An unvisited link that is being “clicked” or otherwise activated, such as via the keyboard, is matched by four of the rules—`:link`, `Lfocus`, `:hover`, and `:active`—so the last one of those four will win out. Given the LVFHA ordering, `:active` will win, which is likely what the author intended.

Assume for a moment that you decide to ignore the common ordering and alphabetize your link styles instead. This would yield:

```
a:active {color: orange;}  
a:focus {color: green;}  
a:hover {color: red;}  
a:link {color: blue;}  
a:visited {color: purple;}
```

Given this ordering, no link would ever show `:hover`, `:focus`, or `:active` styles because the `:link` and `:visited` rules come after the other three. Every link must be either visited or unvisited, so those styles will always override the others.

Let’s consider a variation on the LVFHA order that an author might want to use. In this ordering, only unvisited links will get a hover style; visited links do not. Both visited and unvisited links will get an active style:

```
a:link {color: blue;}  
a:hover {color: red;}  
a:visited {color: purple;}  
a:focus {color: green;}  
a:active {color: orange;}
```

Of course, such conflicts arise only when all the states attempt to set the same property. If each state’s styles address a different property, then the order does not matter. In the following case, the link styles could be given in any

order and would still function as intended:

```
a:link {font-weight: bold;}  
a:visited {font-style: italic;}  
a:focus {color: green;}  
a:hover {color: red;}  
a:active {background: yellow;}
```

You may also have realized that the order of the `:link` and `:visited` styles doesn't matter. You could order the styles LVFHA or VLFHA with no ill effect.

The ability to chain pseudo-classes together eliminates all these worries. The following could be listed in any order without any overrides:

```
a:link {color: blue;}  
a:visited {color: purple;}  
a:link:hover {color: red;}  
a:visited:hover {color: gray;}
```

Because each rule applies to a unique set of link states, they do not conflict. Therefore, changing their order will not change the styling of the document. The last two rules do have the same specificity, but that doesn't matter. A hovered unvisited link will not be matched by the rule regarding hovered visited links, and vice versa. If we were to add active-state styles, then order would start to matter again. Consider:

```
a:link {color: blue;}  
a:visited {color: purple;}  
a:link:hover {color: red;}  
a:visited:hover {color: gray;}  
a:link:active {color: orange;}  
a:visited:active {color: silver;}
```

If the active styles were moved before the hover styles, they would be ignored. Again, this would happen due to specificity conflicts. The conflicts could be avoided by adding more pseudo-classes to the chains, like this:

```
a:link:hover:active {color: orange;}  
a:visited:hover:active {color: silver;}
```

This does have the effect of raising the specificity of the selectors—both have

a specificity value of  $0, 0, 3, 1$ —but they don't conflict because the actual selection states are mutually exclusive. A link can't be an unvisited hovered active link *and* an unvisited hovered active link: only one of the two rules will match, and the styles applied accordingly.

# Non-CSS Presentational Hints

It is possible that a document will contain presentational hints that are not CSS—e.g., the `font` element. Such presentational hints are treated as if they have a specificity of 0 and appear at the *beginning* of the author’s style sheet. Such presentation hints will be overridden by any author or reader styles, but not by the user agent’s styles. In CSS3, presentational hints from outside CSS are treated as if they belong to the user agent’s style sheet, presumably at the end (although as of this writing, the specification doesn’t say).

# Summary

Perhaps the most fundamental aspect of Cascading Style Sheets is the cascade itself—the process by which conflicting declarations are sorted out and from which the final document presentation is determined. Integral to this process is the specificity of selectors and their associated declarations, and the mechanism of inheritance.

# **Chapter 17. Values, Units, and Colors**

In this chapter, we'll tackle features that are the basis for almost everything you can do with CSS: the units that affect the colors, distances, and sizes of a whole host of properties, as well as the units that help to define those values. Without units, you couldn't declare that an image should have 10 pixels of blank space around it, or that a heading's text should be a certain size. By understanding the concepts put forth here, you'll be able to learn and use the rest of CSS much more quickly.

# **Keywords, Strings, and Other Text Values**

Of course, everything in a style sheet is text, but there are certain value types that directly represent strings of text as opposed to, say, numbers or colors. Included in this category are URLs and, interestingly enough, images.

# Keywords

For those times when a value needs to be described with a word of some kind, there are *keywords*. A very common example is the keyword `none`, which is distinct from `0` (zero). Thus, to remove the underline from links in an HTML document, you would write:

```
a:link, a:visited {text-decoration: none;}
```

Similarly, if you want to force underlines on the links, then you would use the keyword `underline`.

If a property accepts keywords, then its keywords will be defined only for the scope of that property. If two properties use the same word as a keyword, the behavior of the keyword for one property will not necessarily be shared with the other. As an example, `normal`, as defined for `letter-spacing`, means something very different than the `normal` defined for `font-style`.

CSS3 defines three “global” keywords: `inherit`, `initial`, and `unset`.

## inherit

The keyword `inherit` makes the value of a property on an element the same as the value of that property on its parent element. In other words, it forces inheritance to occur even in situations where it would not normally operate. In many cases, you don’t need to specify inheritance, since many properties inherit naturally. Nevertheless, `inherit` can still be very useful.

For example, consider the following styles and markup:

```
#toolbar {background: blue; color: white;}  
  
<div id="toolbar">  
  <a href="one.html">One</a> | <a href="two.html">Two</a> |  
  <a href="three.html">Three</a>  
</div>
```

The `div` itself will have a blue background and a white foreground, but the links will be styled according to the browser’s preference settings. They’ll most likely end up as blue text on a blue background, with white vertical bars between them.

You could write a rule that explicitly sets the links in the “toolbar” to be white, but you can make things a little more robust by using `inherit`. You simply add the following rule to the style sheet:

```
#toolbar a {color: inherit;}
```

This will cause the links to use the inherited value of `color` in place of the user agent’s default styles. Ordinarily, directly assigned styles override inherited styles, but `inherit` can undo that behavior.

Similarly, you can pull a property value down from a parent even if it wouldn’t happen normally. Take `border`, for example, which is (rightfully) not inherited. If you want a `span` to inherit the border of its parent, all you need is `span {border: inherit;}`. More likely, though, you just want the border on a `span` to use the same border color as its parent. In that case `span {border-color: inherit;}` will do the trick.

## initial

The keyword `initial` sets the value of a property to the defined initial value, which in a way means it “resets” the value. For example, the default value of `font-weight` is `normal`. Thus, declaring `font-weight: initial` is the same as declaring `font-weight: normal`.

This might seem a little bit silly until you consider that not all values have explicitly defined initial values. For example, the initial value for `color` is “depends on user agent.” That’s not a funky keyword you should type! What it means is that the default value of `color` depends on things like the preferences settings in a browser. While almost nobody changes the default text color setting from black, someone might set it to a dark gray or even a bright red. By declaring `color: initial;`, you’re telling the browser to set the color of the element to whatever the user’s default color is set to be.

## **unset**

The keyword `unset` acts as a universal stand-in for both `inherit` and `initial`. If the property is inherited, then `unset` has the same effect as if `inherit` was used. If the property is *not* inherited, then `unset` has the same effect as if `initial` was used.

### **Warning**

As of late 2016, Opera Mini did not support any of `initial`, `inherit`, or `unset`. Internet Explorer did not support them through IE11.

# Strings

A *string value* is an arbitrary sequence of characters wrapped in either single or double quotes, and is represented in value definitions with `<string>`. Two simple examples:

```
"I like to play with strings."  
'Strings are fun to play with.'
```

Note that the quotes balance, which is to say that you always start and end with the same kind of quotes. Getting this wrong can lead to all kinds of parsing problems, since starting with one kind of quote and trying to end with the other means the string won't actually be terminated. You could accidentally incorporate following rules into the string that way!

If you want to put quote marks inside strings, that's okay as long as they're either not the kind you used to enclose the string or are escaped using a backslash.

```
"I've always liked to play with strings."  
'He said to me, "I like to play with strings."'  
"It's been said that \"haste makes waste.\""  
'There\'s never been a "string theory" that I've liked.'
```

Note that the only acceptable string delimiters are ' and ", sometimes called “straight quotes.” That means you can't use “curly” or “smart” quotes to begin or end a string value. You can use them inside a string value, though, and they don't have to be escaped.

```
"It's been said that "haste makes waste.""  
'There's never been a "string theory" that I've liked.'
```

Of course, this requires that you use Unicode encoding for your documents, but you should be doing that regardless.

If you have some reason to include a newline in your string value, you can do that by escaping the newline itself. CSS will then remove it, making things as if it had never been there. Thus, the following two string values are identical

from a CSS point of view:

```
"This is the right place \
for a newline."
"This is the right place for a newline."
```

If, on the other hand, you actually want a string value that includes a newline character, then use the Unicode reference \A where you want the newline to occur.

```
"This is a better place \Afor a newline."
```

# URLs

If you've written web pages, you're obviously familiar with URLs (or, as in CSS2.1, URIs). Whenever you need to refer to one—as in the `@import` statement, which is used when importing an external style sheet—the general format is:

```
url(protocol://server pathname)
```

This example defines what is known as an *absolute URL*. By absolute, I mean a URL that will work no matter where (or rather, in what page) it's found, because it defines an absolute location in web space. Let's say that you have a server called `web.waffles.org`. On that server, there is a directory called `pix`, and in this directory is an image `waffle22.gif`. In this case, the absolute URL of that image would be:

```
http://web.waffles.org/pix/waffle22.gif
```

This URL is valid no matter where it is found, whether the page that contains it is located on the server `web.waffles.org` or `web.pancakes.com`.

The other type of URL is a *relative URL*, so named because it specifies a location that is relative to the document that uses it. If you're referring to a relative location, such as a file in the same directory as your web page, then the general format is:

```
url(pathname)
```

This works only if the image is on the same server as the page that contains the URL. For argument's sake, assume that you have a web page located at <http://web.waffles.org/syrup.html> and that you want the image `waffle22.gif` to appear on this page. In that case, the URL would be:

```
pix/waffle22.gif
```

This path works because the web browser knows that it should start with the place it found the web document and then add the relative URL. In this case,

the pathname *pix/waffle22.gif* added to the server name

<http://web.waffles.org> equals

<http://web.waffles.org/pix/waffle22.gif>. You can almost always use an absolute URL in place of a relative URL; it doesn't matter which you use, as long as it defines a valid location.

In CSS, relative URLs are relative to the style sheet itself, not to the HTML document that uses the style sheet. For example, you may have an external style sheet that imports another style sheet. If you use a relative URL to import the second style sheet, it must be relative to the first style sheet.

As an example, consider an HTML document at

<http://web.waffles.org/toppings/tips.html>, which has a link to the style sheet <http://web.waffles.org/styles/basic.css>:

```
<link rel="stylesheet" type="text/css"
      href="http://web.waffles.org/styles/basic.css">
```

Inside the file *basic.css* is an @import statement referring to another style sheet:

```
@import url(special/toppings.css);
```

This @import will cause the browser to look for the style sheet at

<http://web.waffles.org/styles/special/toppings.css>, not at

<http://web.waffles.org/toppings/special/toppings.css>. If you have a style sheet at the latter location, then the @import in *basic.css* should read:

```
@import url(http://web.waffles.org/toppings/special/toppings.css)
```

Note that there cannot be a space between the url and the opening parenthesis:

```
body {background: url(http://www.pix.web/picture1.jpg);} /* CORR
body {background: url  (images/picture2.jpg);}           /* INCORR
```

If the space is present, the entire declaration will be invalidated and thus ignored.

# Images

An *image value* is a reference to an image, as you might have guessed. Its syntax representation is `<image>`.

At the most basic level of support, which his to say the one every CSS engine on the planet would understand, an `<image>` value is simply a `<url>` value. In more advanced user agents, `<image>` stands for one of the following:

`<url>`

A URL identifier of an external resource; in this case, the URL of an image.

`<image-set>`

Perhaps unsurprisingly, a set of images, chosen based on a set of conditions embedded into the value. For example, an `image-set()` could specify that a larger image be used for desktop layouts, whereas a smaller image (both in pixel size and file size) be used for a mobile design. It is intended to at least approximate the behavior of the `srcset` attribute for `picture` elements. As of late 2016, browser support for `image-set` was limited to Safari, Chrome, and desktop Opera, and not on par with `srcset`'s full range of capabilities.

`<gradient>`

Refers to either a linear or radial gradient image. Gradients are fairly complex, and thus are covered in detail in another chapter.

# Identifiers

There are a few properties that accept an *identifier value*, which is a user-defined identifier of some kind; the most common example is generated list counters. They are represented in the value syntax as `<identifier>`.

Identifiers themselves are strings, and are case-sensitive; thus, `myID` and `MyID` are, as far as CSS is concerned, completely distinct and unrelated to each other. In cases where a property accepts both an identifier and one or more keywords, the user cannot define an identifier identical to a valid keyword.

# Numbers and Percentages

These value types are special because they serve as the foundation for so many other values types. For example, font sizes can be defined using the `em` identifier (covered later in this text) preceded by a number. But what kind of number? Defining the types of numbers here lets us speak clearly later on.

# Integers

An *integer value* is about as simple as it gets: one or more numbers, optionally prefixed by a + or - sign to indicate a positive or negative value. That's it. Integer values are represented in value syntax as `<integer>`. Examples include 13, -42, 712, and 1066.

Integer values that fall outside a defined range are, by default, considered invalid and cause the entire declaration to be ignored. However, some properties define behavior that causes values outside the accepted range to be set to the accepted value closest to the declared value, known as “clamping.” In cases (such as the property `z-index`) where there is no restricted range, user agents must support values up to  $\pm 1,073,741,824$  ( $\pm 2^{30}$ ).

# Numbers

A *number value* is either an `<integer>` or a real number, which is to say an integer followed by a dot and then some number of following integers. Additionally, it can be prefixed by either `+` or `-` to indicate positive or negative values. Number values are represented in value syntax as `<number>`. Examples include `2.7183`, `-3.1416`, and `6.2832`.

The reason a `<number>` can be an `<integer>` and yet there are separate value types is that some properties will only accept integers (e.g., `z-index`), whereas others will accept any real number (e.g., `flex-grow`). As with integer values, number values may have limits imposed on them by a property definition; for example, `opacity` restricts its value to be any valid `<number>` in the range `0` to `1`, inclusive. By default, number values that fall outside a defined range are, by default, considered invalid and cause the entire declaration to be ignored. However, some properties define behavior that causes values outside the accepted range to be set to the accepted value closest to the declared value (generally referred to as “clamping”).

# Percentages

A *percentage value* is a `<number>` followed by a percentage sign (%), and is represented in value syntax as `<percentage>`. Examples would include `50%` and `33.333%`. Percentage values are always relative to another value, which can be anything—the value of another property of the same element, a value inherited from the parent element, or a value of an ancestor element. Any property that accepts percentage values will define any restrictions on the range of allowed percentage values, and will also define the way in which the percentage is relatively calculated.

# Distances

Many CSS properties, such as margins, depend on length measurements to properly display various page elements. It's no surprise, then, that there are a number of ways to measure length in CSS.

All length units can be expressed as either positive or negative numbers followed by a label, although note that some properties will accept only positive numbers. You can also use real numbers—that is, numbers with decimal fractions, such as 10.5 or 4.561. All length units are followed by short abbreviation (usually two characters) that represents the actual unit of length being specified, such as `in` (inches) or `pt` (points). The only exception to this rule is a length of `0` (zero), which need not be followed by a unit.

These length units are divided into two types: *absolute length units* and *relative length units*.

# Absolute Length Units

We'll start with absolute units because they're easiest to understand, despite the fact that they're almost unusable in regular web design. The six types of absolute units are as follows:

## *Inches (in)*

As you might expect, this notation refers to the inches you'd find on a ruler in the United States. (The fact that this unit is in the specification, even though almost the entire world uses the metric system, is an interesting insight into the pervasiveness of U.S. interests on the Internet —but let's not get into virtual sociopolitical theory right now.)

## *Centimeters (cm)*

Refers to the centimeters that you'd find on rulers the world over. There are 2.54 centimeters to an inch, and one centimeter equals 0.394 inches.

## *Millimeters (mm)*

For those Americans who are metric-challenged, there are 10 millimeters to a centimeter, so an inch equals 25.4 millimeters, and a millimeter equals 0.0394 inches.

## *Quarter-millimeters (q)*

There are 40 Q units in a centimeter; thus, setting an element to be one-tenth of a centimeter wide—which is also to say, a millimeter wide—would mean a value of  $4q$ . (Only Firefox supported  $q$  as of late 2016.)

## *Points (pt)*

Points are standard typographical measurements that have been used by printers and typesetters for decades and by word processing programs for many years. Traditionally, there are 72 points to an inch (points were

defined before widespread use of the metric system). Therefore, the capital letters of text set to 12 points should be one-sixth of an inch tall. For example, `p {font-size: 18pt;}` is equivalent to `p {font-size: 0.25in;}`.

### *Picas (pc)*

Picas are another typographical term. A pica is equivalent to 12 points, which means there are 6 picas to an inch. As just shown, the capital letters of text set to 1 pica should be one-sixth of an inch tall. For example, `p {font-size: 1.5pc;}` would set text to the same size as the example declarations found in the definition of points.

### *Pixels (px)*

A pixel is a small box on screen, but CSS defines pixels more abstractly. In CSS terms, a pixel is defined to be the size required to yield 96 pixels per inch. Many user agents ignore this definition in favor of simply addressing the pixels on the monitor. Scaling factors are brought into play when page zooming or printing, where an element `100px` wide can be rendered more than 100 device dots wide.

Of course, these units are really useful only if the browser knows all the details of the monitor on which your page is displayed, the printer you're using, or whatever other user agent might apply. On a web browser, display is affected by the size of the monitor and the resolution to which the monitor is set—and there isn't much that you, as the author, can do about these factors. You can only hope that, if nothing else, the measurements will be consistent in relation to each other—that is, that a setting of `1.0in` will be twice as large as `0.5in`, as shown in [Figure 17-1](#).

[one] This paragraph has a one-"inch" left margin.

[two] This paragraph has a half-"inch" left margin.

**Figure 17-1.** Setting absolute-length left margins

Nevertheless, despite all that, let's make the highly suspect assumption that

your computer knows enough about its display system to accurately reproduce real-world measurements. In that case, you could make sure every paragraph has a top margin of half an inch by declaring `p {margin-top: 0.5in;}`. Regardless of font size or any other circumstances, a paragraph will have a half-inch top margin.

Absolute units are much more useful in defining style sheets for printed documents, where measuring things in terms of inches, points, and picas is much more common.

## Pixel lengths

On the face of things, pixels are straightforward. If you look at a monitor closely enough, you can see that it's broken up into a grid of tiny little boxes. Each box is a pixel. If you define an element to be a certain number of pixels tall and wide, as in the following markup:

```
<p>  
The following image is 20 pixels tall and wide:   
</p>
```

...then it follows that the element will be that many monitor elements tall and wide, as shown in [Figure 17-2](#).

The following image is 20 pixels tall and wide: 

**Figure 17-2. Using pixel lengths**

In general, if you declare something like `font-size: 18px`, a web browser will almost certainly use actual pixels on your monitor—after all, they're already there—but with other display devices, like printers, the user agent will have to rescale pixel lengths to something more sensible. In other words, the printing code has to figure out how many dots there are in a pixel.

On the other hand, pixel measurements are often useful for expressing the size of images, which are already a certain number of pixels tall and wide. Of

course, these days, responsive design means that we often want to express image size in relation to the size of the text or the width of the viewport, regardless of the number of actual pixels in the image. You do end up relying on the image-scaling routines in user agents, but those have been getting pretty good. Scaling of images *really* makes sense with vector-based images like SVG, of course.

## Pixel theory

In its discussion of pixels, the CSS specification recommends that, in cases where a display's resolution density is significantly different than 96 pixels per inch (ppi), user agents should scale pixel measurements to a "reference pixel." CSS2 recommended 90ppi as the reference pixel, but CSS2.1 and CSS3 recommend 96ppi. The most common example is a printer, which has dots instead of pixels, and which has a lot more dots per inch than 96! In printing web content, then, it may assume 96 pixels per inch and scale its output accordingly.

If a display's resolution is set to 1,024 pixels wide by 768 pixels tall, its screen size is exactly ten and two-thirds inches wide by eight inches tall, and the screen it is filled entirely by the display pixels, then each pixel will be 1/96 of an inch wide and tall. As you might guess, this scenario is a fairly rare occurrence. So, on most displays, the actual number of pixels per inch (ppi) is higher than 96—sometimes much higher. The Retina display on an iPhone 4S, for example, is 326ppi; the display on the iPad 3,264ppi.

### Note

As a Windows XP user, you should be able to set your display driver to make the display of elements correspond correctly to real-world measurements. The path to the ruler dialog is Start→Control Panel; double-click Display; click the Settings tab; then click Advanced to reveal a dialog box (which may differ on each PC). You should see a dropdown or other form control labeled "Font Size;" select "Other."

# Resolution Units

With the advent of media queries and responsive designs, three new unit types were introduced in order to be able to describe display resolution:

## *Dots per inch (dpi)*

The number of display dots per linear inch. This can refer to the dots in a paper printer's output, the physical pixels in an LED monitor or other device, or the elements in an e-ink display such as that used by a Kindle.

## *Dots per centimeter (dpcm)*

Same as `dpi`, except the linear measure is one centimeter instead of one inch.

## *Dots per pixel unit (dppx)*

The number of display dots per CSS `px` unit, as described previously. As of CSS3, `1dppx` is equivalent to `96dpi` because CSS defines pixel units at that ratio. Of course, that ratio could change in future versions of CSS.

As of late 2016, these units are only used in the context of media queries. As an example, an author can create a media block to be used only on displays that have higher than 500dpi:

```
@media (min-resolution: 500dpi) { ... }
```

# Relative Length Units

Relative units are so called because they are measured in relation to other things. The actual (or absolute) distance they measure can change due to factors beyond their control, such as screen resolution, the width of the viewing area, the user's preference settings, and a whole host of other things. In addition, for some relative units, their size is almost always relative to the element that uses them and will thus change from element to element.

## em and ex units

First, let's consider `em` and `ex`, which are closely related. In CSS, one “`em`” is defined to be the value of `font-size` for a given font. If the `font-size` of an element is 14 pixels, then for that element, `1em` is equal to 14 pixels.

Obviously, this value can change from element to element. For example, let's say you have an `h1` with a font size of 24 pixels, an `h2` element with a font size of 18 pixels, and a paragraph with a font size of 12 pixels. If you set the left margin of all three at `1em`, they will have left margins of 24 pixels, 18 pixels, and 12 pixels, respectively:

```
h1 {font-size: 24px;}  
h2 {font-size: 18px;}  
p {font-size: 12px;}  
h1, h2, p {margin-left: 1em;}  
small {font-size: 0.8em;}  
  
<h1>Left margin = <small>24 pixels</small></h1>  
<h2>Left margin = <small>18 pixels</small></h2>  
<p>Left margin = <small>12 pixels</small></p>
```

When setting the size of the font, on the other hand, the value of `em` is relative to the font size of the parent element, as illustrated by [Figure 17-3](#).

**Left margin = 24 pixels**

**Left margin = 18 pixels**

Left margin = 12 pixels

**Figure 17-3.** Using em for margins and font sizing

In theory, one “em” is equal to the width of a lowercase “m” in the font used—that’s where the name comes from, in fact. It’s an old typographer’s term. However, this is not assured in CSS.

`ex`, on the other hand, refers to the height of a lowercase *x* in the font being used. Therefore, if you have two paragraphs in which the text is 24 points in size, but each paragraph uses a different font, then the value of `ex` could be different for each paragraph. This is because different fonts have different heights for *x*, as you can see in [Figure 17-4](#). Even though the examples use 24-point text—and therefore, each example’s `em` value is 24 points—the *x*-height for each is different.

Times: x

Garamond: x

Helvetica: x

Arial: x

Impact: x

Courier: x

Figure 17-4. Varying x-heights

## The rem unit

Like the `em` unit, the `rem` unit is based on declared font size. The difference—and it's a doozy—is that whereas `em` is calculated using the font size of the element to which it's applied, `rem` is *always* calculated using the root element. In HTML, that's the `html` element. Thus, declaring any element to have `font-size: 1rem;` is setting it to have the same font-size value as the root element of the document.

As an example, consider the following markup fragment. It will have the

result shown in [Figure 17-5](#).

```
<p> This paragraph has the same font size as the root element tha
<div style="font-size: 30px; background: silver;">
  <p style="font-size: 1em;">This paragraph has the same font siz
    <p style="font-size: 1rem;">This paragraph has the same font si
</div>
```

This paragraph has the same font size as the root element thanks to inheritance.

## This paragraph has the same font size as its parent element.

This paragraph has the same font size as the root element.

**Figure 17-5. ems versus rems**

In effect, `rem` acts as a reset for font size: no matter what relative font sizing has happened to the ancestors of an element, giving it `font-size: 1rem;` will put it right back where the root element is set. This will usually be the user's default font size, unless of course you (or the user) have set the root element to a specific font size.

For example, given this declaration, `1rem` will always be equivalent to `13px`:

```
html {font-size: 13px;}
```

However, given *this* declaration, `1rem` will always be equivalent to three-quarters the user's default font size:

```
html {font-size: 75%;}
```

In this case, if the user's default is 16 pixels, then `1rem` will equal `12px`. If the user has actually set their default to 12 pixels—a few people do this—then `1rem` will equal `9px`; if the default setting is 20 pixels, then `1rem` equals `15px`. And so on.

Of course, you are not restricted to the value `1rem`. Any real number can be used, just as with the `em` unit, so you can do fun things like set all of your headings to be multiples of the root element's font size:

```
h1 {font-size: 2rem;}
h2 {font-size: 1.75rem;}
```

```
h3 {font-size: 1.4rem; }
h4 {font-size: 1.1rem; }
h5 {font-size: 1rem; }
h6 {font-size: 0.8rem; }
```

**Note**

In browsers that support the keyword `initial` (see previously), `font-size: 1rem` is equivalent to `font-size: initial` as long as no font size is set for the root element.

## The ch unit

An interesting addition to CSS3 is the `ch` unit, which is broadly meant to represent “one character.” The way it is defined in CSS3 is:

Equal to the advance measure of the “0” (ZERO, U+0030) glyph found in the font used to render it.

The term “advance measure” is actually a CSS-ism that corresponds to the term “advance width” in font typography. (CSS uses the term “measure” because some scripts are not right-to-left or left-to-right, and so may have an advance height rather than an advance width.) Without getting into too many details, a character glyph’s advance width is the distance from the start of a character glyph to the start of the next. This generally corresponds to the width of the glyph itself plus any built-in spacing to the sides. (Although that built-in spacing can be either positive or negative.)

As mentioned previously, CSS pins the `ch` unit to the advance width of a zero in a given font. This is in parallel to the way that `em` is calculated with respect to the `font-size` value of an element.

The easiest way to demonstrate this unit is to run a bunch of zeroes together and then set an image to have a width with the same number of `ch` units as the number of zeroes, as shown in [Figure 17-6](#).

```
img {height: 1em; width: 25ch; }
```

This example uses Times.

0000000000000000000000000000

This example uses Garamond.

0000000000000000000000000000

This example uses Helvetica.

0000000000000000000000000000

This example uses Arial.

0000000000000000000000000000

**This example uses Impact.**

0000000000000000000000000000

This example uses Courier.

0000000000000000000000000000

Figure 17-6. Character-relative sizing

Given a monospace font, all characters are by definition  $1\text{ch}$  wide. In any proportional face type, which is what the vast majority of Western typefaces are, characters may be wider or narrower than the “0” and so cannot be assumed to be  $1\text{ch}$  wide.

#### Warning

As of late 2016, only Opera Mini and Internet Explorer had problems with  $\text{ch}$ . In IE11,  $\text{ch}$  was mis-measured to be exactly the width of the “0” glyph, not the glyph plus the small amount of space to either side of it. Thus,  $5\text{ch}$  was less than the width of “00000” in IE11. This error was corrected in Edge.

## Viewport-relative units

Another new addition in CSS3 are the three viewport-relative size units. These are calculated with respect to the size of the viewport—browser

window, printable area, mobile device display, etc.

### *Viewport width unit (vw)*

This unit is calculated with respect to the viewport's width, which is divided by 100. Therefore, if the viewport is 937 pixels wide,  $1\text{vw}$  is equal to  $9.37\text{px}$ . If the viewport's width changes, say by dragging the browser window wider or more narrow, the value of  $\text{vw}$  changes along with it.

### *Viewport height unit (vh)*

This unit is calculated with respect to the viewport's height, which is divided by 100. Therefore, if the viewport is 650 pixels tall,  $1\text{vh}$  is equal to  $6.5\text{px}$ . If the viewport's height changes, say by dragging the browser window taller or shorter, the value of  $\text{vh}$  changes along with it.

### *Viewport minimum unit (vmin)*

This unit is 1/100 of the viewport's width or height, whichever is *lesser*. Thus, given a viewport that is 937 pixels wide by 650 pixels tall,  $1\text{vmin}$  is equal to  $6.5\text{px}$ .

### *Viewport maximum unit (vmax)*

This unit is 1/100 of the viewport's width or height, whichever is *greater*. Thus, given a viewport that is 937 pixels wide by 650 pixels tall,  $1\text{max}$  is equal to  $9.37\text{px}$ .

Note that these are length units like any other, and so can be used anywhere a length unit is permitted. You can scale the font size of a heading in terms of the viewport height, for example, with something like `h1 {font-size: 10vh;}`. This sets the font size to be one-tenth the height of the viewport—a technique potentially useful for article titles and the like.

These units can be particularly handy for creating full-viewport interfaces, such as those one would expect to find on a mobile device, because it can allow elements to be sized compared to the viewport and not any of the

elements within the document tree. It's thus very simple to fill up the entire viewport, or at least major portions of it, and not have to worry about the precise dimensions of the actual viewport in any particular case.

Here's a very basic example of viewport-relative sizing, which is illustrated in [Figure 17-7](#).

```
div {width: 50vh; height: 33vw; background: gray;}
```

An interesting (though perhaps not useful) fact about these units is that they aren't bound to their own primary axis. Thus, for example, you can declare `width: 25vh;` to make an element as wide as one-quarter the height of the viewport.

#### Warning

As of late 2016, viewport-relative units were supported by all browsers except Opera Mini, plus the odd exception that `vmax` is not supported in Microsoft browsers.

A div! It is half the width of the viewport and a third the height. Six of them could create a full-viewport UI.

A paragraph which follows the single `div` we actually have in this example.

**Figure 17-7. Viewport-relative sizing**

# Calculation values

In situations where you need to do a little math, CSS provides a `calc()` value. Inside the parentheses, you can construct simple mathematical expressions. The permitted operators are `+` (addition), `-` (subtraction), `*` (multiplication), and `/` (division), as well as parentheses. These follow the traditional PEMDAS (Parentheses, Exponents, Multiplication, Division, Addition, Subtraction) precedence order, although in this case it's really just PMDAS since exponents are not permitted in `calc()`.

## Note

Support for parentheses in `calc()` appears to be a convenience provided by browsers, since they're not mentioned in the syntax definition for `calc()`. It seems likely that support for parentheses will remain, but use at your own risk.

As an example, suppose you want your paragraphs to have a width that's 2em less than 90% the width of their parent element. Here's how you express that with `calc()`:

```
p {width: calc(90% - 2em);}
```

`calc()` can be used anywhere one of the following value types is permitted: `<length>`, `<frequency>`, `<angle>`, `<time>`, `<percentage>`, `<number>`, and `<integer>`. You can also use all these unit types within a `calc()` value, though there are some limitations to keep in mind.

The basic limitation is that `calc()` does basic type checking to make sure that units are, in effect, compatible. The checking works like this:

1. To either side of a `+` or `-` sign, both values must have the same unit type, or be a `<number>` and `<integer>` (in which case, the result is a `<number>`). Thus, `5 + 2.7` is valid, and results in `7.7`. On the other hand, `5em + 2.7` is invalid, because one side has a length unit and the other

does not. Note that  $5\text{em} + 20\text{px}$  is valid, because `em` and `px` are both length units.

2. Given a `*`, one of the values involved must be a `<number>` (which, remember, includes integer values). So  $2.5\text{rem} * 2$  and  $2 * 2.5\text{rem}$  are both valid, and each result in  $5\text{rem}$ . On the flip side,  $2.5\text{rem} * 2\text{rem}$  is not valid, because the result would be  $5\text{rem}^2$ , and length units cannot be area units.
3. Given a `/`, the value on the *right* side must be a `<number>`. If the left side is an `<integer>`, the result is a `<number>`. Otherwise, the result is of the unit type used on the left side. This means that  $30\text{em} / 2.75$  is valid, but  $30 / 2.75\text{em}$  is not valid.
4. Furthermore, any circumstance that yields division by zero is invalid. This is easiest to see in a case like  $30\text{px}/0$ , but there are other ways to get there.

There's one more notable limitation, which is that whitespace is *required* to either side of the `+` and `-` operators, while it is not for `*` and `/`. This avoids ambiguity with respect to values which can be negative.

Beyond that, the specification requires that user agents support a *minimum* of 20 terms inside a `calc()` expression, where a term is a number, percentage, or dimension (length). In situations where the number of terms somehow exceeds the user agent's term limits, the entire expression is treated as invalid.

# Attribute Values

In a few CSS properties, it's possible to pull in the value of an HTML attribute defined for the element being styled. This is done with the `attr()` expression.

For example, with generated content, you can insert the value of any attribute. It looks something like this (don't worry about understanding the exact syntax, which we'll explore in a later chapter):

```
p::before {content: "[" attr(id) "]";}
```

That expression would prefix any paragraph that has an `id` attribute with the value of that `id`, enclosed in square brackets. Therefore, applying the previous style to the following paragraphs would have the result shown in [Figure 17-8](#).

```
<p id="leadoff">This is the first paragraph.</p>
<p>This is the second paragraph.</p>
<p id="conclusion">This is the third paragraph.</p>
```

[leadoff]This is the first paragraph.

[]This is the second paragraph.

[conclusion]This is the third paragraph.

**Figure 17-8. Inserting attribute values**

It's theoretically possible to use `attr()` in almost any property value, specifying the value type within the expression. For example, you could (again, in theory) use the `maxlength` attribute on an input field to determine its width, as shown here:

```
input[type="text"] {width: attr(maxlength em);}
```

```
<input type="text" maxlength="10">
```

Given that setup, the `input` element would be styled to be 10em wide, assuming a user agent that supports this use of `attr()`. As of late 2016, this was not the case: no tested browser supported this application of `attr()`.

# Color

One of the first questions every starting web author asks is, “How do I set colors on my page?” Under HTML, you have two choices: you could use one of a small number of colors with names, such as `red` or `purple`, or employ a vaguely cryptic method using hexadecimal codes. Both of these methods for describing colors remain in CSS, along with some other—and, I think, more intuitive—methods.

# Named Colors

Assuming that you're content to pick from a small, basic set of colors, the easiest method is simply to use the name of the color you want. CSS calls these color choices, logically enough, *named colors*. As of CSS3, the CSS color specification defines 16 basic color keywords, which are the 16 colors defined in HTML 4.01, as shown in [Table 17-1](#).

Table 17-1. The basic 16 color keywords

aqua gray navy silver

black green olive teal

blue lime purple white

fuchsia maroon red yellow

So, let's say you want all first-level headings to be maroon. The best declaration would be:

```
h1 {color: maroon;}
```

Simple and straightforward, isn't it? [Figure 17-9](#) shows a few more examples:

```
h1 {color: silver;}  
h2 {color: fuchsia;}  
h3 {color: navy;}
```

**Greetings!**

**Salutations!**

**Howdy-do!**

**Figure 17-9.** Naming colors

Of course, you've probably seen (and maybe even used) color names other than the ones listed earlier. For example, if you specify:

```
h1 {color: lightgreen;}
```

As of the CSS3 color specification, the 16 colors from HTML 4.01 have been subsumed into a longer list of 147 color keywords. This extended list is based on the standard X11 RGB values that have been in use for decades, and have been recognized by browsers for many years, with the addition of some color names from SVG (mostly involving variants of "gray" and "grey"). A table of color equivalents for all 147 keywords defined in the CSS Color Module Level 3 is given in ["Color Equivalence Table"](#).

Fortunately, there are more detailed and precise ways to specify colors in CSS. The advantage is that, with these methods, you can specify any color in the color spectrum, not just 17 (or 140) named colors.

# Colors by RGB and RGBa

Computers create colors by combining different levels of red, green, and blue, a combination that is often referred to as *RGB color*. Each point of display is known as a pixel, which is a term discussed earlier in the chapter. Given the way colors are created on a monitor, it makes sense that you should have direct access to those colors, determining your own mixture of the three for maximum control. That solution is complex, but possible, and the payoffs are worth it because there are very few limits on which colors you can produce. There are four ways to affect color in this manner.

## Functional RGB colors

There are two color value types that use *functional RGB notation* as opposed to hexadecimal notation. The generic syntax for this type of color value is `rgb(color)`, where `color` is expressed using a triplet of either percentages or integers. The percentage values can be in the range 0%–100%, and the integers can be in the range 0–255.

Thus, to specify white and black, respectively, using percentage notation, the values would be:

```
rgb(100%, 100%, 100%)  
rgb(0%, 0%, 0%)
```

Using the integer-triplet notation, the same colors would be represented as:

```
rgb(255, 255, 255)  
rgb(0, 0, 0)
```

Assume you want your `h1` elements to be a shade of red that lies between the values for red and maroon. `red` is equivalent to `rgb(100%, 0%, 0%)`, whereas `maroon` is equal to `(50%, 0%, 0%)`. To get a color between those two, you might try this:

```
h1 {color: rgb(75%, 0%, 0%);}
```

This makes the red component of the color lighter than `maroon`, but darker than `red`. If, on the other hand, you want to create a pale red color, you would raise the green and blue levels:

```
h1 {color: rgb(75%,50%,50%);}
```

The closest equivalent color using integer-triplet notation is:

```
h1 {color: rgb(191,127,127);}
```

The easiest way to visualize how these values correspond to color is to create a table of gray values. The result is shown in [Figure 17-10](#):

```
p.one {color: rgb(0%,0%,0%);}  
p.two {color: rgb(20%,20%,20%);}  
p.three {color: rgb(40%,40%,40%);}  
p.four {color: rgb(60%,60%,60%);}  
p.five {color: rgb(80%,80%,80%);}  
p.six {color: rgb(0,0,0);}  
p.seven {color: rgb(51,51,51);}  
p.eight {color: rgb(102,102,102);}  
p.nine {color: rgb(153,153,153);}  
p.ten {color: rgb(204,204,204);}
```

[one] This is a paragraph.  
[two] This is a paragraph.  
[three] This is a paragraph.  
[four] This is a paragraph.  
[five] This is a paragraph.  
[six] This is a paragraph.  
[seven] This is a paragraph.  
[eight] This is a paragraph.  
[nine] This is a paragraph.  
[ten] This is a paragraph.

**Figure 17-10.** Text set in shades of gray

Of course, since we're dealing in shades of gray, all three RGB values are the same in each statement. If any one of them were different from the others, then a color hue would start to emerge. If, for example, `rgb(50%,50%,50%)`

were modified to be `rgb(50%, 50%, 60%)`, the result would be a medium-dark color with just a hint of blue.

It is possible to use fractional numbers in percentage notation. You might, for some reason, want to specify that a color be exactly 25.5 percent red, 40 percent green, and 98.6 percent blue:

```
h2 {color: rgb(25.5%, 40%, 98.6%);}
```

A user agent that ignores the decimal points (and some do) should round the value to the nearest integer, resulting in a declared value of `rgb(26%, 40%, 99%)`. In integer triplets, of course, you are limited to integers.

Values that fall outside the allowed range for each notation are “clipped” to the nearest range edge, meaning that a value that is greater than `100%` or less than `0%` will default to those allowed extremes. Thus, the following declarations would be treated as if they were the values indicated in the comments:

```
P.one {color: rgb(300%, 4200%, 110%); }      /* 100%,100%,100% */
P.two {color: rgb(0%, -40%, -5000%); }      /* 0%,0%,0% */
p.three {color: rgb(42, 444, -13); }        /* 42,255,0 */
```

Conversion between percentages and integers may seem arbitrary, but there’s no need to guess at the integer you want—there’s a simple formula for calculating them. If you know the percentages for each of the RGB levels you want, then you need only apply them to the number 255 to get the resulting values. Let’s say you have a color of 25 percent red, 37.5 percent green, and 60 percent blue. Multiply each of these percentages by 255, and you get 63.75, 95.625, and 153. Round these values to the nearest integers, and *voilà*: `rgb(64, 96, 153)`.

Of course, if you already know the percentage values, there isn’t much point in converting them into integers. Integer notation is more useful for people who use programs such as Photoshop, which can display integer values in the “Info” dialog, or for those who are so familiar with the technical details of color generation that they normally think in values of 0–255.

## RGBa colors

As of CSS3, the two functional RGB notations were extended into a functional RGba notation. This notation simply adds an alpha value to the end of the RGB triplets; thus, “red-green-blue-alpha” becomes RGba. The alpha stands for *alpha channel*, which is a measure of opacity.

For example, suppose you wanted an element’s text to be half-opaque white. That way, any background color behind the text would “shine through,” mixing with the half-transparent white. You would write one of the following two values:

```
rgba(255, 255, 255, 0.5)  
rgba(100%, 100%, 100%, 0.5)
```

To make a color completely transparent, you simply set the alpha value to 0; to be completely opaque, the correct value is 1. Thus, `rgb(0, 0, 0)` and `rgba(0, 0, 0, 1)` will yield precisely the same result (black). [Figure 17-11](#) shows a series of paragraphs set in increasingly transparent black, which is the result of the following rules.

```
p.one {color: rgba(0,0,0,1);}  
p.two {color: rgba(0%,0%,0%,0.8);}  
p.three {color: rgba(0,0,0,0.6);}  
p.four {color: rgba(0%,0%,0%,0.4);}  
p.five {color: rgba(0,0,0,0.2);}
```

[one] This is a paragraph.  
[two] This is a paragraph.  
[three] This is a paragraph.  
[four] This is a paragraph.  
[five] This is a paragraph.

**Figure 17-11.** Text set in progressive translucency

As you’ve no doubt already inferred, alpha values are always real numbers in the range 0 to 1. Any value outside that range will either be ignored or reset to the nearest valid alpha value. You cannot use `<percentage>` to represent

alpha values, despite the mathematical equivalence.

## Hexadecimal RGB colors

CSS allows you to define a color using the same hexadecimal color notation so familiar to old-school HTML web authors:

```
h1 {color: #FF0000;} /* set H1s to red */
h2 {color: #903BC0;} /* set H2s to a dusky purple */
h3 {color: #000000;} /* set H3s to black */
h4 {color: #808080;} /* set H4s to medium gray */
```

Computers have been using “hex notation” for quite some time now, and programmers are typically either trained in its use or pick it up through experience. Their familiarity with hexadecimal notation likely led to its use in setting colors in HTML. The practice was simply carried over to CSS.

Here’s how it works: by stringing together three hexadecimal numbers in the range `00` through `FF`, you can set a color. The generic syntax for this notation is `#RRGGBB`. Note that there are no spaces, commas, or other separators between the three numbers.

Hexadecimal notation is mathematically equivalent to the integer-pair notation discussed in the previous section. For example, `rgb(255, 255, 255)` is precisely equivalent to `#FFFFFF`, and `rgb(51, 102, 128)` is the same as `#336680`. Feel free to use whichever notation you prefer—it will be rendered identically by most user agents. If you have a calculator that converts between decimal and hexadecimal, making the jump from one to the other should be pretty simple.

For hexadecimal numbers that are composed of three matched pairs of digits, CSS permits a shortened notation. The generic syntax of this notation is `#RGB`:

```
h1 {color: #000;} /* set H1s to black */
h2 {color: #666;} /* set H2s to dark gray */
h3 {color: #FFF;} /* set H3s to white */
```

As you can see from the markup, there are only three digits in each color value. However, since hexadecimal numbers between `00` and `FF` need two

digits each, and you have only three total digits, how does this method work?

The answer is that the browser takes each digit and replicates it. Therefore, #FOO is equivalent to #FF0000, #6FA would be the same as #66FFAA, and #FFF would come out #FFFFFF, which is the same as white. Obviously, not every color can be represented in this manner. Medium gray, for example, would be written in standard hexadecimal notation as #808080. This cannot be expressed in shorthand; the closest equivalent would be #888, which is the same as #888888.

## Hexadecimal RGBa colors

A new, and not yet widely supported, hexadecimal notation adds a fourth hex value to represent the alpha channel value. [Figure 17-11](#) shows a series of paragraphs set in increasingly transparent black, just as we saw in the previous section, which is the result of the following rules.

```
p.one {color: #000000FF; }
p.two {color: #000000CC; }
p.three {color: #00000099; }
p.four {color: #00000066; }
p.five {color: #00000033; }
```

[one] This is a paragraph.  
[two] This is a paragraph.  
[three] This is a paragraph.  
[four] This is a paragraph.  
[five] This is a paragraph.

**Figure 17-12. Text set in progressive translucency, redux**

As with non-alpha hexadecimal values, it's possible to shorten a value composed of matched pairs to a four-digit value. Thus, a value of #663399AA can be written as #639A. If the value has any pairs that are not repetitive, then the entire eight-digit value must be written out: #663399CA cannot be shortened to #639CA.

# Colors by HSL and HSLa

New to CSS3 (though not to the world of color theory in general) are HSL notations. HSL stands for *H*ue, *S*aturation, and *L*ightness, where the hue is a hue angle in the range 0–360, saturation is a percentage value from 0 (no saturation) to 100 (full saturation), and lightness is a percentage value from 0 (completely dark) to 100 (completely light).

The hue angle is expressed in terms of a circle around which the full spectrum of colors progresses. It starts with red at zero degrees and then proceeds through the rainbow until it comes to red again at 360 degrees. [Figure 17-13](#) illustrates this visually by showing the angles and colors of the spectrum on a wheel as well as a linear strip.

If you're intimately familiar with RGB, then HSL may be confusing at first. (But then, RGB is confusing for people familiar with HSL.) You may be able to better grasp the hues in HSL by contemplating the diagram in [Figure 17-14](#), which shows the spectrum results from placing and then mixing red, green, and blue.

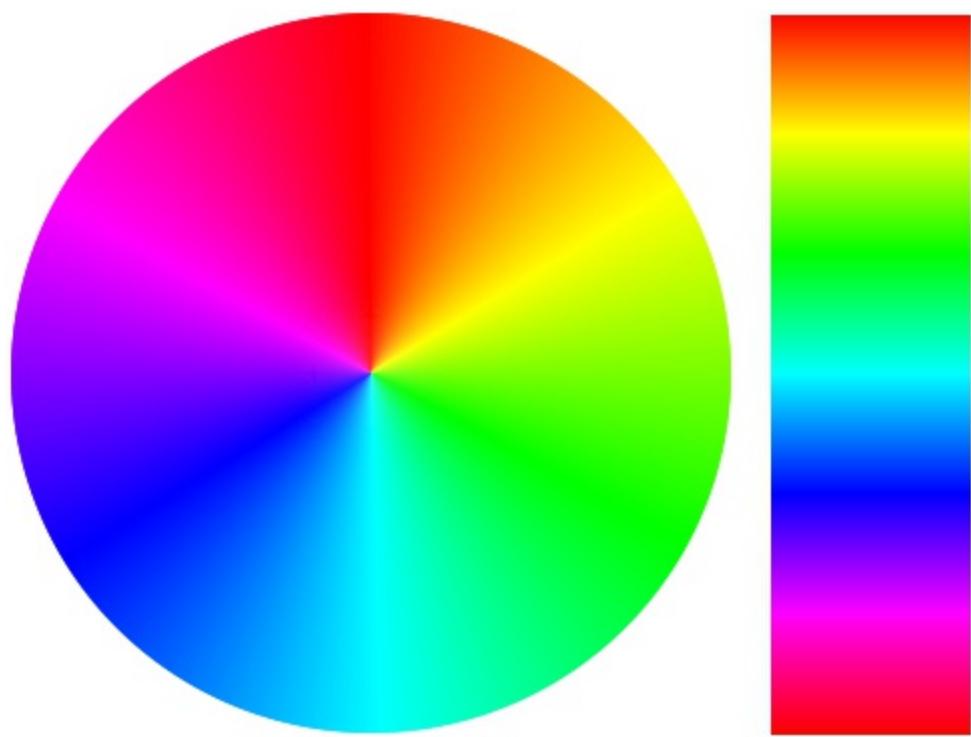
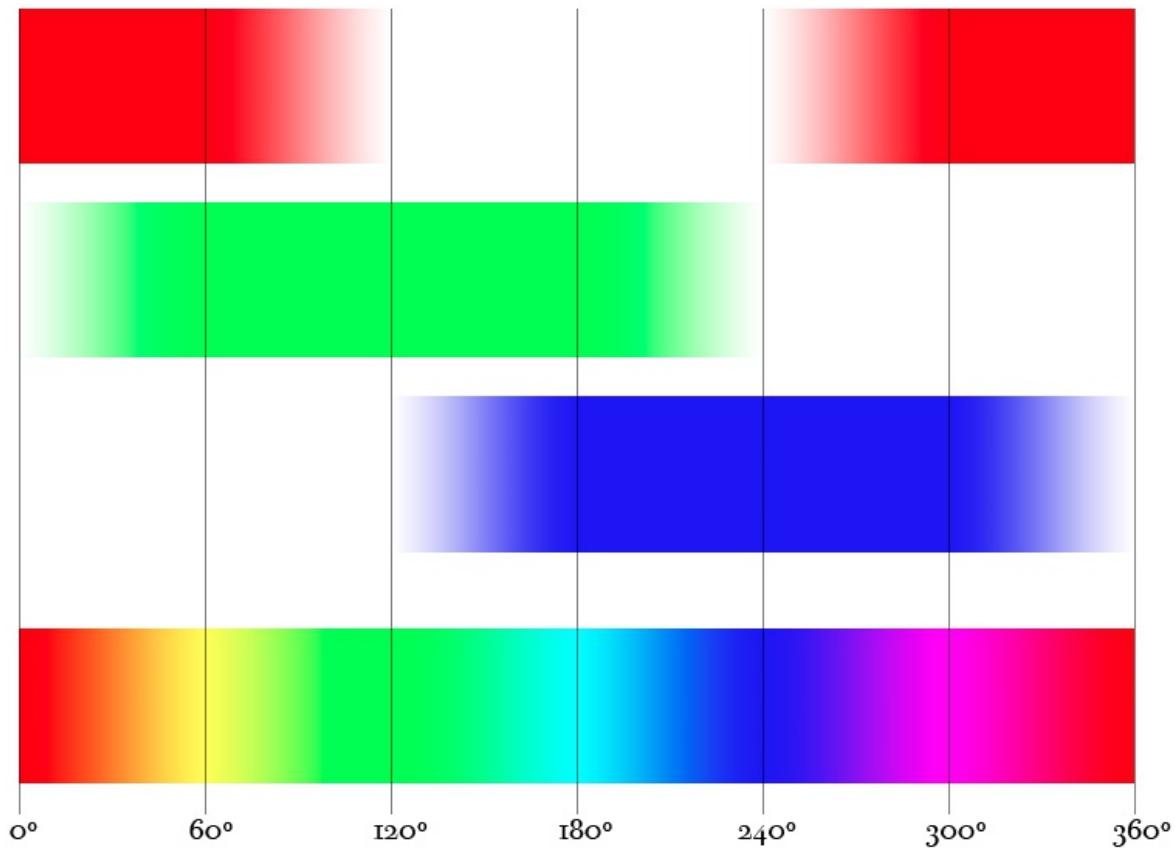


Figure 17-13. The spectrum on a wheel and a strip



**Figure 17-14. Mixing RGB to create the spectrum**

As for the other two values, saturation measures the intensity of a color. A saturation of 0% always yields a shade of gray, no matter what hue angle you have set, and a saturation of 100% creates the most vivid possible shade of that hue for a given lightness. Similarly, lightness defines how dark or light the color appears. A lightness of 0% is always black, regardless of the other hue and saturation values, just as a lightness of 100% always yields white. Consider the results of the following styles, illustrated on the left side of [Figure 17-15](#).

```
p.one {color: hsl(0,0%,0%);}  
p.two{color: hsl(60,0%,25%);}  
p.three {color: hsl(120,0%,50%);}  
p.four {color: hsl(180,0%,75%);}  
p.five {color: hsl(240,0%,0%);}  
p.six {color: hsl(300,0%,25%);}  
p.seven {color: hsl(360,0%,50%);}
```

[one] This paragraph's color has 0% saturation.  
[two] This paragraph's color has 0% saturation.  
[three] This paragraph's color has 0% saturation.  
[four] This paragraph's color has 0% saturation.  
[five] This paragraph's color has 0% saturation.  
[six] This paragraph's color has 0% saturation.  
[seven] This paragraph's color has 0% saturation.

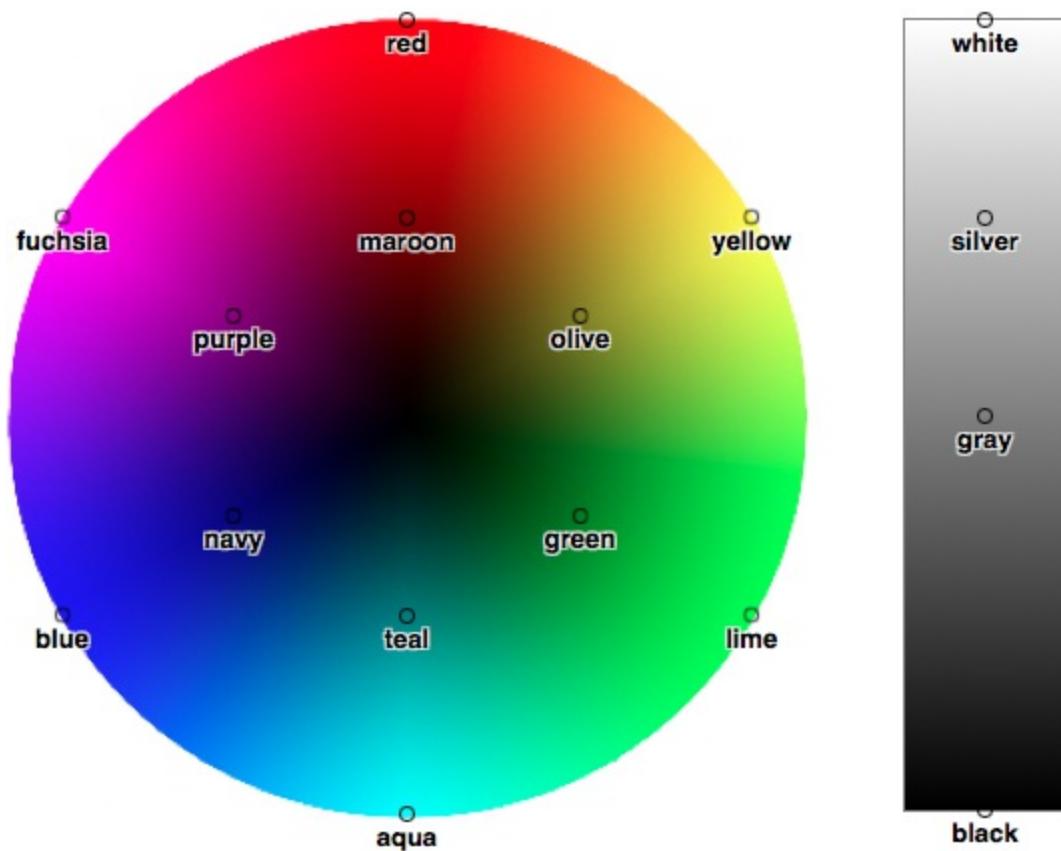
[one] This paragraph's color has 50% saturation.  
[two] This paragraph's color has 50% saturation.  
**[three] This paragraph's color has 50% saturation.**  
**[four] This paragraph's color has 50% saturation.**  
[five] This paragraph's color has 50% saturation.  
[six] This paragraph's color has 50% saturation.  
**[seven] This paragraph's color has 50% saturation.**

**Figure 17-15. Varying lightness and hues**

The gray you see on the left side isn't just a function of the limitations of print: every single one of those bits of text is a shade of gray, because every color value has 0% in the saturation (middle) position. The degree of lightness or darkness is set by the lightness (third) position. In all seven examples, the hue angle changes, and in none of them does it matter. But that's only so long as the saturation remains at 0%. If that value is raised to, say, 50%, then the hue angle will become very important, because it will control what sort of color you see. Consider the same set of values that we saw before, but all set to 50%

saturation, as illustrated on the right side of [Figure 17-15](#).

It can be instructive to take the 16 color keywords defined in HTML4 ([Table 17-1](#)) and plot them against a hue-and-lightness wheel, as shown in [Figure 17-16](#). The color wheel not only features the full spectrum around the rim, but also runs from 50 percent lightness at the edge to 0 percent lightness in the center. (The saturation is 100 percent throughout.) As you can see, the twelve keywords of color are regularly placed throughout the wheel, which bespeaks careful choice on the part of whoever chose them. The gray shades aren't quite as regularly placed, but are probably the most useful distribution of shades given that there were only four of them.



**Figure 17-16. Keyword-equivalent hue angles and lightnesses**

Just as RGB has its RGBa counterpart, HSL has an HSLa counterpart. This is simply an HSL triplet followed by an alpha value in the range 0–1. The following HSLa values are all black with varying shades of transparency, just as in the RGBa section earlier (and illustrated in [Figure 17-11](#)).

```
p.one {color: hsla(0,0%,0%,1);}  
p.two {color: hsla(0,0%,0%,0.8);}  
p.three {color: hsla(0,0%,0%,0.6);}  
p.four {color: hsla(0,0%,0%,0.4);}  
p.five {color: hsla(0,0%,0%,0.2);}
```

# Bringing the Colors Together

[Table 17-2](#) presents an overview of some of the colors we've discussed. Note that there are some rows that do not contain shortened hexadecimal values. That happens in cases where the longer (six-digit) values cannot be shortened. For example, the value #880 expands to #888800, not #808000 (otherwise known as `olive`). Therefore, there is no shortened version of #808000, and the appropriate entry in the table is blank.

Table 17-2. Color equivalents

Color	Hexadecimal	RGB Decimal	RGB Percentage	HS
aqua	#00FFFF / #0FF	rgb(0, 255, 255)	rgb(0%, 100%, 100%)	hsl(180, 1
black	#000000 / #000	rgb(0, 0, 0)	rgb(0%, 0%, 0%)	hsl(0, 0%,
blue	#0000FF / #00F	rgb(0, 0, 255)	rgb(0%, 0%, 100%)	hsl(240, 1
fuchsia	#FF00FF / #F0F	rgb(255, 0, 255)	rgb(100%, 0%, 100%)	hsl(300, 1
gray	#808080	rgb(128, 128, 128)	rgb(50%, 50%, 50%)	hsl(0, 0%,
green	#008000	rgb(0, 128, 0)	rgb(0%, 50%, 0%)	hsl(120, 1
lime	#00FF00 / #0F0	rgb(0, 255, 0)	rgb(0%, 100%, 0%)	hsl(120, 1

maroon	#800000	rgb(128, 0, 0)	rgb(50%, 0%, 0%)	hsl(0, 100%
navy	#000080	rgb(0, 0, 128)	rgb(0%, 0%, 50%)	hsl(240, 1
olive	#808000	rgb(128, 128, 0)	rgb(50%, 50%, 0%)	hsl(60, 10
purple	#800080	rgb(128, 0, 128)	rgb(50%, 0%, 50%)	hsl(300, 1
red	#FF0000 / #FOO	rgb(255, 0, 0)	rgb(100%, 0%, 0%)	hsl(0, 100
silver	#C0C0C0	rgb(192, 192, 192)	rgb(75%, 75%, 75%)	hsl(0, 0%,
teal	#008080	rgb(0, 128, 128)	rgb(0%, 50%, 50%)	hsl(180, 1
white	#FFFFFF / #FFF	rgb(255, 255, 255)	rgb(100%, 100%, 100%)	hsl(0, 0%,
yellow	#FFFF00 / #FF0	rgb(255, 255, 0)	rgb(100%, 100%, 0%)	hsl(60, 10

# Angles

Since we just finished talking about hue angles in HSL, this would be a good time to talk about angle units. Angles in general are represented as `<angle>`, which is a `<number>` followed by one of four unit types:

`deg`

Degrees, of which there are 360 in a full circle.

`grad`

Gradians, of which there are 400 in a full circle. Also known as “grades” or “gons.”

`rad`

Radians, of which there are  $2\pi$  (approximately 6.28) in a full circle.

`turn`

Turns, of which there is one in a full circle. This unit is mostly useful when animating a rotation and you wish to have it turn multiple times, such as `10turn` to make it spin ten times. (Sadly, the pluralization `turns` is invalid, at least as of late 2016.)

Table 17-3. Angle equivalents

Degrees	Gradians	Radians	Turns
---------	----------	---------	-------

45deg	50grad	0.785rad	0.125turn
-------	--------	----------	-----------

90deg	100grad	1.571rad	0.25turn
-------	---------	----------	----------

180deg	200grad	3.142rad	0.5turn
--------	---------	----------	---------

270deg 300grad 4.712rad 0.75turn

360deg 400grad 6.283rad 1turn

Angle units are mostly used in 2D and 3D transforms, though they do appear in a few other places. Note that angle units are *not* used in HSL colors, where all hue angle values are *always* degrees and thus do not use the `deg` unit!

# Time and Frequency

In cases where a property needs to express a period of time, the value is represented as `<time>` and is a `<number>` followed by either `s` (seconds) or `ms` (milliseconds.) Time values are most often used in transitions and animations, either to define durations or delays. The following two declarations will have exactly the same result.

```
a[href] {transition-duration: 2.4s;}  
a[href] {transition-duration: 2400ms;}
```

Time values are also used in aural CSS, again to define durations or delays, but support for aural CSS is extremely limited as of this writing.

Another value type historically used in aural CSS is `<frequency>`, which is a `<number>` followed by either `Hz` (Hertz) or `kHz` (kiloHertz). As usual, the identifiers are case-insensitive, so `Hz` and `hz` are equivalent. The following two declarations will have exactly the same result:

```
h1 {pitch: 128hz;}  
h1 {pitch: 0.128khz;}
```

# Position

A *position value* is how you specify the placement of an origin image in a background area, and is represented as `<position>`. Its syntactical structure is rather complicated:

```
[ [ left | center | right | top | bottom | <percentage> |  
<length> ] | [ left | center | right | <percentage> | <length> ]  
[ top | center | bottom | <percentage> | <length> ] | [ center |  
[ left | right ] [ <percentage> | <length> ]? ] && [ center | [  
top | bottom ] [ <percentage> | <length> ]? ] ]
```

That might seem a little nutty, but it's all down to the subtly complex patterns that this value type has to allow.

If you declare only one value, such as `left` or `25%`, then a second value is set to `center`. Thus, `left` is the same as `left center` and `25%` is the same as `25% center`.

If you declare (either implicitly, as above, or explicitly) two values and the first one is a length or percentage, then it is *always* considered to be the horizontal value. This means that given `25% 35px`, the `25%` is a horizontal distance and the `35px` is a vertical distance. If you swap them to say `35px 25%`, then `35px` is horizontal and `25%` is vertical. This means that if you write `25% left or 35px right`, the entire value is invalid because you have supplied two horizontal distances and no vertical distance. (Similarly, a value of `right left or top bottom` is invalid and will be ignored.) On the other hand, if you write `left 25% or right 35px`, there is no problem because you've given a horizontal distance (with the keyword) and a vertical distance (with the percentage or length).

If you declare four values (we'll deal with three just in a moment), then you must have two lengths or percentages, each of which is preceded by a keyword. In this case, each length or percentage specifies an offset distance, and each keyword defines the edge from which the offset is calculated. Thus, `right 10px bottom 30px` means an offset of 10 pixels to the left of the right

edge, and an offset of 30 pixels up from the bottom edge. Similarly, `top 50% left 35px` means a 50 percent offset from the top and a 35-pixels-to-the-right offset from the left.

If you declare three values, the rules are the same as for four except the last offset is set to be zero (no offset). Thus `right 20px top` is the same as `right 20px top 0`.

# Summary

Units and values cover a wide spectrum of areas, from length units to special keywords that describe effects (such as `underline`) to color units to the location of files (such as images). For the most part, units are the one area that user agents get almost totally correct, but it's those few little bugs and quirks that can get you. Navigator 4.x's failure to interpret relative URLs correctly, for example, has bedeviled many authors and led to an overreliance on absolute URLs. Colors are another area where user agents almost always do well, except for a few little quirks here and there. The vagaries of length units, however, far from being bugs, are an interesting problem for any author to tackle. These units all have their advantages and drawbacks, depending upon the circumstances in which they're used.

# **Color Equivalence Table**