Chapter 1. The Basics: Getting Started Quickly

Get going with Python programming as quickly as possible.
In this chapter, we introduce the basics of programming in Python, and we do this in typical *Head First* style: by jumping right in. After just a few pages, you'll have run your first sample program. By the end of the chapter, you'll not only be able to run the sample program, but you'll understand its code too (and more besides). Along the way, you'll learn about a few of the things that make **Python** the programming language it is. So, let's not waste any more time. Flip the page and let's get going!

Breaking with Tradition

Pick up almost any book on a programming language, and the first thing you'll see is the *Hello World* example.

No, we aren't.

This is a *Head First* book, and we do things differently 'round here. With other books, there is a tradition to start by showing you how to write the *Hello World* program in the language under consideration. However, with Python, what you end up with is a single statement that invokes Python's built-in `print` function, which displays the traditional “Hello, World!” message on screen. It’s almost too exciting...and it teaches you next to nothing.

So, no, we aren’t going to show you the *Hello World* program in Python, as there’s really nothing to learn from it. We’re going to take a different path...

STARTING WITH A MEATIER EXAMPLE

Our plan for this chapter is to start with an example that’s somewhat larger and, consequently, more useful than *Hello World*.

We’ll be right up front and tell you that the example we have is somewhat *contrived*: it does do something, but may not be entirely useful in the long run. That said, we’ve chosen it to provide a vehicle with which to cover a lot of Python in as short a timespan as possible. And we promise by the time you’ve worked through the first example program, you’ll know enough to write *Hello World* in Python without our help.

Jump Right In

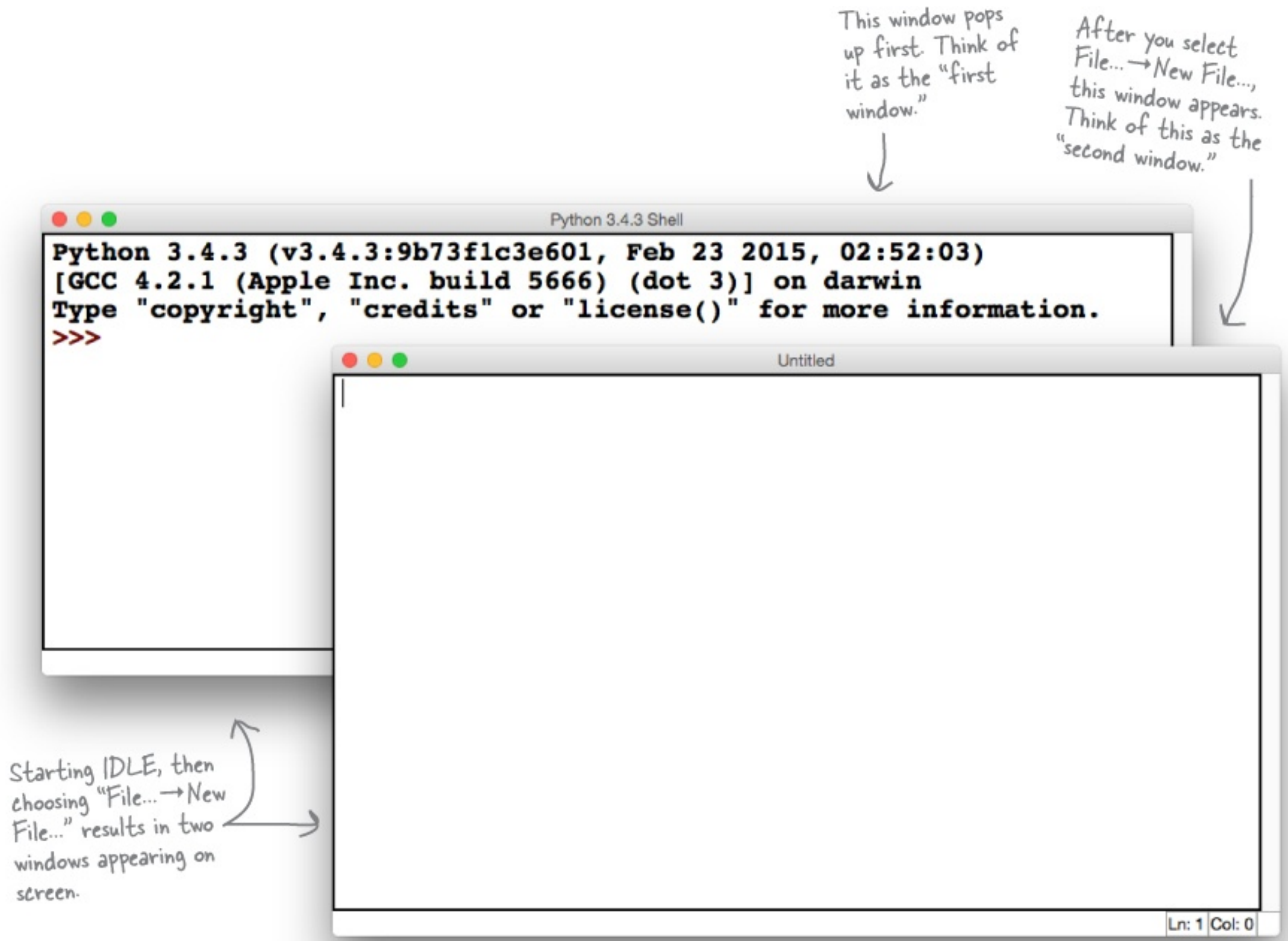
If you haven’t already installed a version of Python 3 on your computer, pause now and head on over to Appendix A for some step-by-step installation instructions (it’ll only take a couple minutes, promise).

With the latest Python 3 installed, you’re ready to start programming Python, and to help with this—for now—we’re going to use Python’s built-in integrated development environment (IDE).

PYTHON’S IDLE IS ALL YOU NEED TO GET GOING

When you install Python 3 on your computer, you also get a very simple yet usable IDE called IDLE. Although there are many different ways in which to run Python code (and you’ll meet a lot of them throughout this book), IDLE is all you need when starting out.

Start IDLE on your computer, then use the *File...→New File...* menu option to open a new editing window. When we did this on our computer, we ended up with two windows: one called the Python Shell and another called Untitled:



Understanding IDLE’s Windows

Both of these IDLE windows are important.

The first window, the Python Shell, is a REPL environment used to run snippets of Python code, typically a single statement at a time. The more you work with Python, the more you’ll come to love the Python Shell, and you’ll be using it a lot as you progress through this book. For now, though, we are more interested in the second window.

The second window, Untitled, is a text editing window that can be used to write complete Python programs. It’s not the greatest editor in the world (as that honor goes to <*insert your favorite text editor’s name here*>), but IDLE’s editor is quite usable, and has a bunch of modern features built right in, including color-syntax handling and the like.

GEEK BITS

What does REPL mean?

It‘s geek shorthand for “read-eval-print-loop,” and describes an interactive programming tool that lets you experiment with snippets of code to your heart’s desire. Find out way more than you need to know by visiting *http://en.wikipedia.org/wiki/Read-eval-print_loop*.

As we are jumping right in, let’s go ahead and enter a small Python program into this window. When you are done typing in the code below, use the *File...*→*Save...* menu option to save your program under the name `odd.py`.

Be sure to enter the code *exactly* as shown here:

odd.py - /Users/Paul/Desktop/_NewBook/ch01/odd.py (3.4.3)

```
from datetime import datetime

odds = [ 1,  3,  5,  7,  9, 11, 13, 15, 17, 19,
        21, 23, 25, 27, 29, 31, 33, 35, 37, 39,
        41, 43, 45, 47, 49, 51, 53, 55, 57, 59 ]

right_this_minute = datetime.today().minute

if right_this_minute in odds:
    print("This minute seems a little odd.")
else:
    print("Not an odd minute.")
```

Ln: 15 Col: 0

Don't worry about what this code does for now. Just type it into the editing window. Be sure to save it as “odd.py” before continuing.

So...*now what?* If you're anything like us, you can't wait to run this code, right? Let's do this now. With your code in the edit window (as shown above), press the F5 key on your keyboard. A number of things can happen...

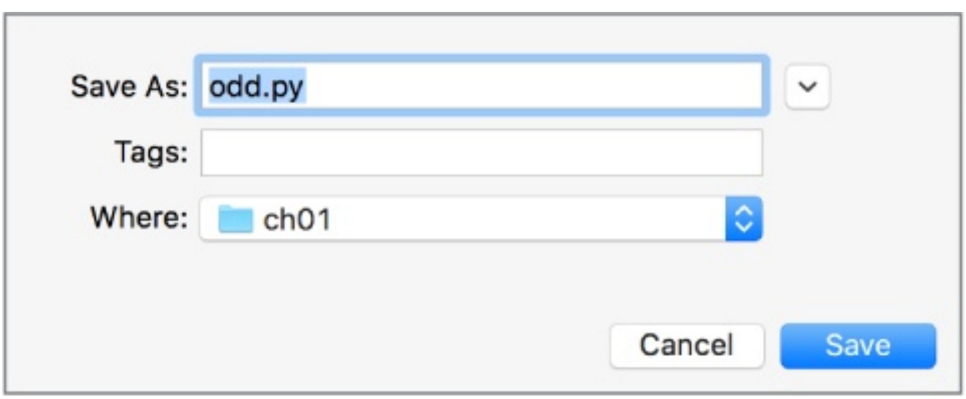
What Happens Next...

If your code ran without error, flip over to the next page, and *keep going*.

If you forgot to save your code *before* you tried to run it, IDLE complains, as you have to save any new code to a file *first*. You'll see a message similar to this one if you didn't save your code:

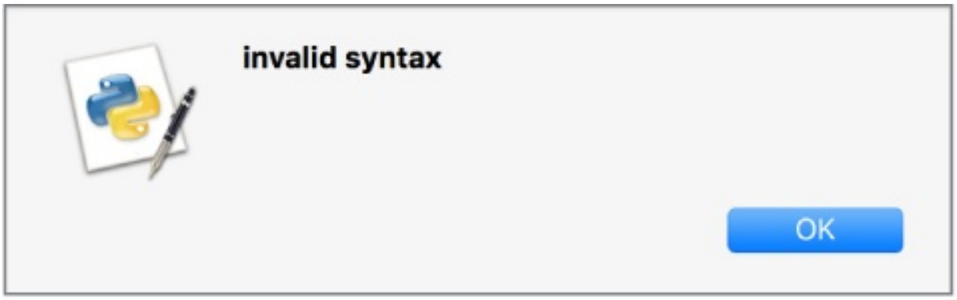
By default, IDLE won't run code that hasn't been saved.

Click the OK button, then provide a name for your file. We've chosen `odd` as the name for our file, and we've added a `.py` extension (which is a Python convention well worth adhering to):



You are free to use whatever name you like for your program, but it's probably best—if you're following along—to stick to the same name as us.

If your code now runs (having been saved), flip over to the next page, and *keep going*. If, however, you have a syntax error somewhere in your code, you'll see this message:



As you can no doubt tell, IDLE isn't great at stating what the syntax error is. But click OK, and a large red block indicates where IDLE thinks the problem is.

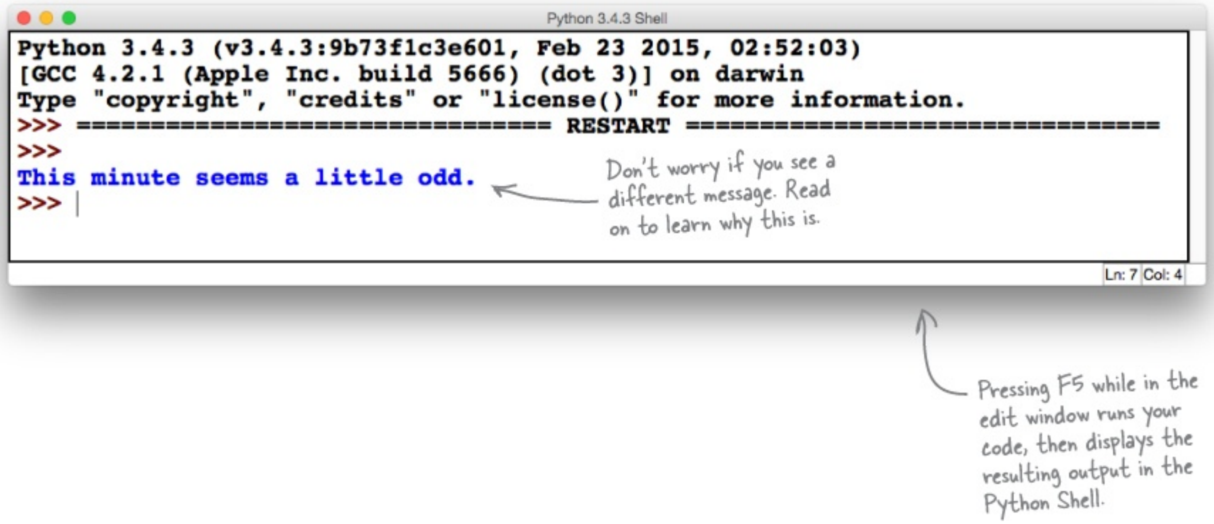
Click the OK button, then note where IDLE thinks the syntax error is: look for the large red block in the edit window. Make sure your code matches ours exactly, save your file again, and then press F5 to ask IDLE to execute your code once more.

Press F5 to Run Your Code

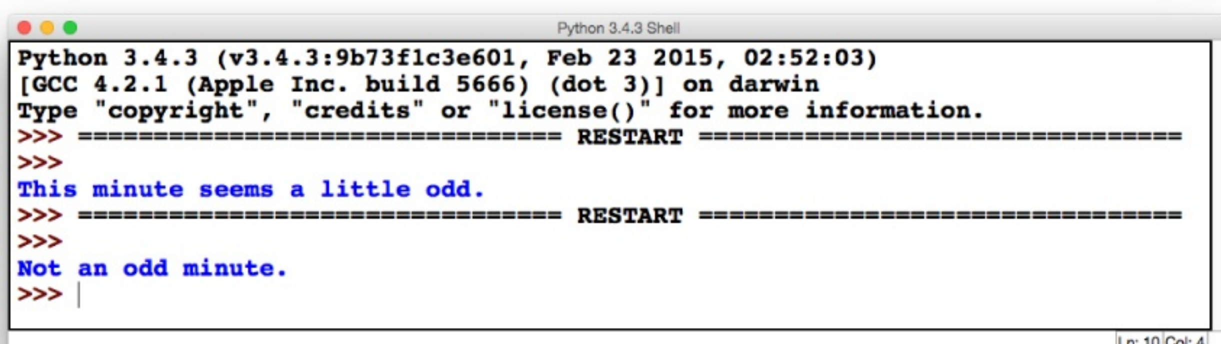
Pressing F5 executes the code in the currently selected IDLE text-editing window—assuming, of course, that your code doesn't contain a runtime error. If you have a runtime error, you'll see a **Traceback** error message (in red). Read the message, then return to the edit window to make sure the code you entered is exactly the same as ours. Save your amended code, then press F5 again. When we pressed F5, the Python Shell became the active window, and here's what we saw:

NOTE

From this point on, we'll refer to "the IDLE text-editing window" simply as "the edit window."



Depending on what time of day it is, you may have seen the *Not an odd minute* message instead. Don't worry if you did, as this program displays one or the other message depending on whether your computer's current time contains a minute value that's an odd number (we did say this example was *contrived*, didn't we?). If you wait a minute, then click the edit window to select it, then press F5 again, your code runs again. You'll see the other message this time (assuming you waited the required minute). Feel free to run this code as often as you like. Here is what we saw when we (very patiently) waited the required minute:

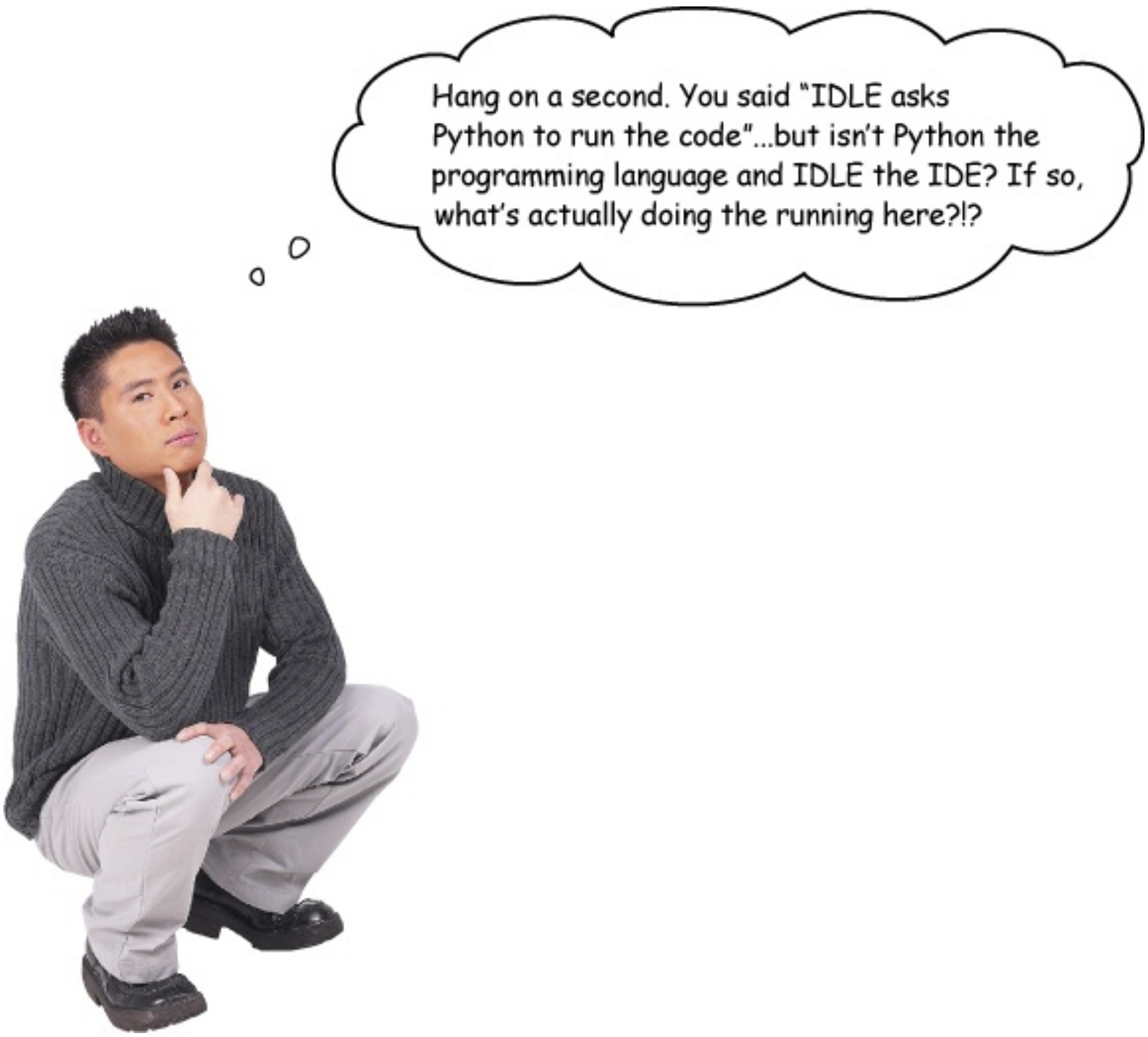


Let's spend some time learning how this code runs.

Code Runs Immediately

When IDLE asks Python to run the code in the edit window, Python starts at the top of the file and begins executing code straightaway.

For those of you coming to Python from one of the C-like languages, note that there is no notion of a `main()` function or method in Python. There's also no notion of the familiar edit-compile-link-run process. With Python, you edit your code and save it, and run it *immediately*.



Oh, good catch. That is confusing.

Here's what you need to know: "Python" is the name given to the programming language and "IDLE" is the name given to the built-in Python IDE.

That said, when you install Python 3 on your computer, an **interpreter** is installed, too. This is the technology that runs your Python code. Rather confusingly, this interpreter is also known by the name "Python." By right, everyone should use the more correct name when referring to this technology, which is to call it "the Python interpreter." But, alas, nobody ever does.

Starting this very second, in this book, we'll use the word "Python" to refer to the language, and the word "interpreter" to refer to the technology that runs your Python code. "IDLE" refers to the IDE, which takes your Python code and runs it through the interpreter. It's the interpreter that does all the actual work here.

THERE ARE NO DUMB QUESTIONS

Q: **Q: Is the Python interpreter something like the Java VM?**

A: **A:** *Yes and no. Yes, in that the interpreter runs your code. But no, in how it does it. In Python, there's no real notion of your source code being compiled into an "executable." Unlike the Java VM, the interpreter doesn't run* `.class` *files, it just runs your code.*

Q: **Q: But, surely, compilation has to happen at some stage?**

A: **A:** *Yes, it does, but the interpreter does not expose this process to the Python programmer (you). All of the details are taken care of for you. All you see is your code running as IDLE does all the heavy lifting, interacting with the interpreter on your behalf. We'll talk more about this process as this book progresses.*

Executing Code, One Statement at a Time

Here is the program code from page 4 again:

```
from datetime import datetime

odds = [ 1,  3,  5,  7,  9, 11, 13, 15, 17, 19,

        21, 23, 25, 27, 29, 31, 33, 35, 37, 39,

        41, 43, 45, 47, 49, 51, 53, 55, 57, 59 ]
```

```
right_this_minute = datetime.today().minute

if right_this_minute in odds:

    print("This minute seems a little odd.")

else:

    print("Not an odd minute.")
```

LET'S BE THE PYTHON INTERPRETER

Let's take some time to run through this code in much the same way that the interpreter does, line by line, from the *top* of the file to the *bottom*.

Think of modules as a collection of related functions.

The first line of code **imports** some preexisting functionality from Python's **standard library,** which is a large stock of software modules providing lots of prebuilt (and high-quality) reusable code.

In our code, we specifically request one submodule from the standard library's `datetime` module. The fact that the submodule is also called `datetime` is confusing, but that's how this works. The `datetime` submodule provides a mechanism to work out the time, as you'll see over the next few pages.

This is the name of the submodule.

```
from datetime import datetime

odds = [ 1,  3,  5,  7,  9, 11, 13, 15, 17, 19,
        21, 23, 25, 27, 29, 31, 33, 35, 37, 39,
        41, 43, 45, 47, 49, 51, 53, 55, 57, 59 ]
              ...
```

This is the name of the standard library module to import the reusable code from.

Remember: the interpreter starts at the top of the file and works down toward the bottom, executing each line of Python code as it goes.

In this book, when we want you to pay particular attention to a line of code, we highlight it (just like we did here).

Functions + Modules = The Standard Library

Python's **standard library** is very *rich*, and provides a lot of reusable code.

Let's look at another module, called `os`, which provides a platform-independent way to interact with your underlying operating system (we'll return to the `datetime` module in a moment). Let's concentrate on just one provided function, `getcwd`, which—when invoked—returns your *current working directory*.

Here's how you'd typically *import*, then *invoke*, this function within a Python program:

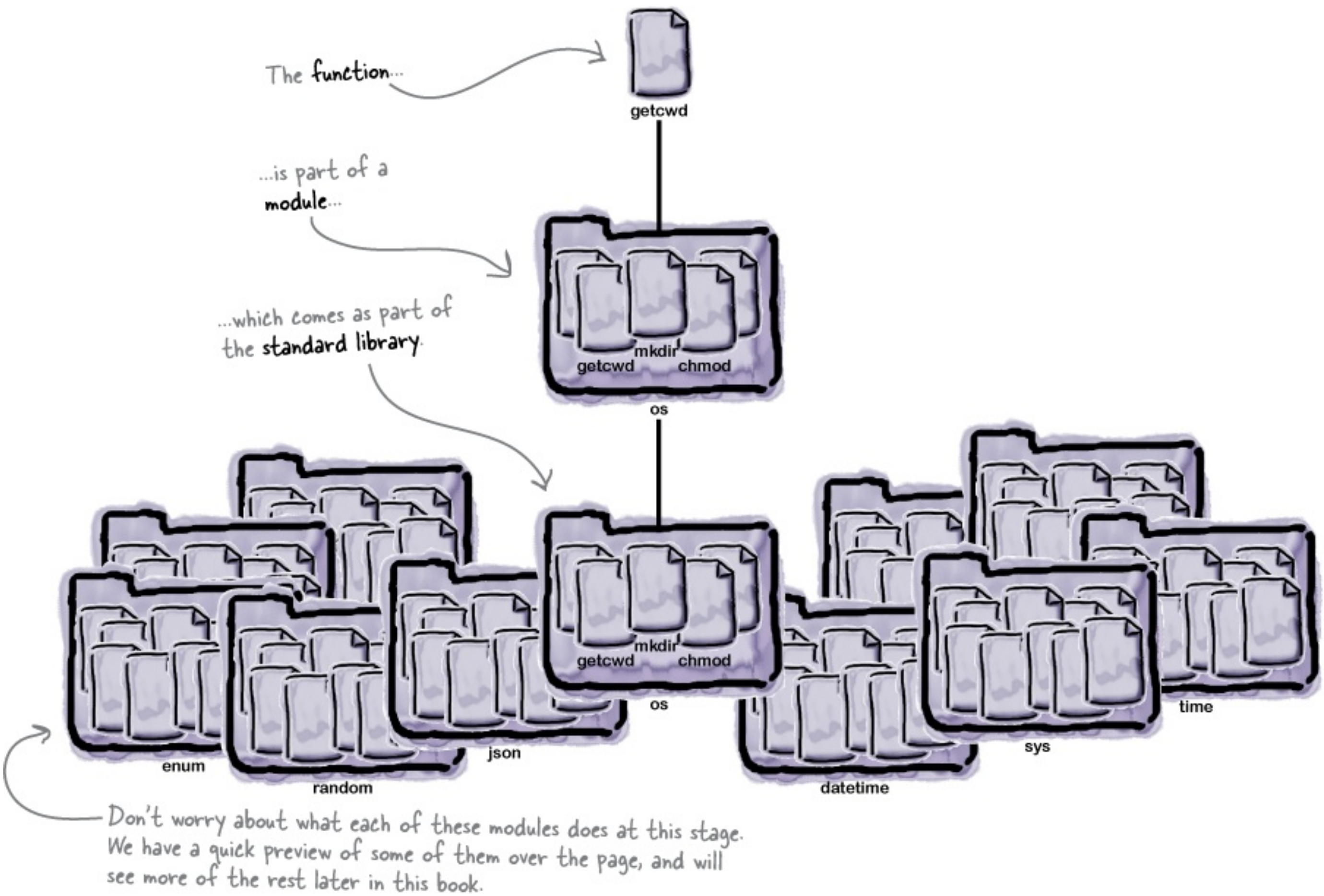
Import the function from its module...

```
from os import getcwd

where_am_I = getcwd()
```

...then invoke as required.

A collection of related functions makes up a module, and there are *lots* of modules in the standard library:

Functions are inside modules inside the standard library.



UP CLOSE WITH THE STANDARD LIBRARY

The **standard library** is the jewel in Python's crown, supplying reusable modules that help you with everything from, for example, working with data, through manipulating ZIP archives, to sending emails, to working with HTML. The standard library even includes a web server, as well as the popular *SQLite* database technology. In this *Up Close*, we'll present an overview of just a few of the most commonly used modules in the standard library. To follow along, you can enter these examples as shown at your >>> prompt (in IDLE). If you are currently looking at IDLE's edit window, choose *Run...*→*Python Shell* from the menu to access the >>> prompt.

Let's start by learning a little about the system your interpreter is running on. Although Python prides itself on being cross-platform, in that code written on one platform can be executed (generally unaltered) on another, there are times when it's important to know that you are running on, say, *Mac OS X*. The `sys` module exists to help you learn more about your interpreter's system. Here's how to determine the identity of your underlying operating system, by first importing the `sys` module, then accessing the `platform` attribute:

```
>>> import sys
>>> sys.platform
'darwin'
```

Import the module you need, then access the attribute of interest. It looks like we are running "darwin", which is the Mac OS X kernel name.

The `sys` module is a good example of a reusable module that primarily provides access to preset attributes (such as `platform`). As another example, here's how to determine which version of Python is running, which we pass to the `print`function to display on screen:

```
>>> print(sys.version)
3.4.3 (v3.4.3:9b73f1c3e601, Feb 23 2015, 02:52:03)
[GCC 4.2.1 (Apple Inc. build 5666) (dot 3)]
```

There's a lot of information the Python version we're run including that it's 3.4.3.

The `os` module is a good example of a reusable module that primarily yields functionality, as well as providing a system-independent way for your Python code to interact with the underlying operating system, regardless of exactly which operating system that is.

For example, here's how to work out the name of the folder your code is operating within using the `getcwd` function. As with any module, you begin by importing the module before invoking the function:

```
>>> import os
>>> os.getcwd()
'/Users/HeadFirst/CodeExamples'
```

Import the module, then invoke the functionality you need.

You can access your system's environment variables, as a whole (using the `environ` attribute) or individually (using the `getenv` function):

The "environ" attribute contains lots of data.

```
>>> os.environ
'environ({'XPC_FLAGS': '0x0', 'HOME': '/Users/HeadFirst', 'TMPDIR': '/var/
folders/18/t93gmhc546b7b2cngfhz10100000gn/T/', ... 'PYTHONPATH': '/Applications/
Python 3.4/IDLE.app/Contents/Resources', ... 'SHELL': '/bin/bash', 'USER':
'HeadFirst'})'
>>> os.getenv('HOME')
'/Users/HeadFirst'
```

You can access a specifically named attribute (from the data contained in "environ") using "getenv".

Working with dates (and times) comes up a lot, and the standard library provides the `datetime` module to help when you're working with this type of data. The `date.today` function provides today's date:

```
>>> import datetime
>>> datetime.date.today()
datetime.date(2015, 5, 31)
```

Today's date

That's certainly a strange way to display today's date, though, isn't it? You can access the day, month, and year values separately by appending an attribute access onto the call to `date.today`:

```
>>> datetime.date.today().day
31
>>> datetime.date.today().month
5
>>> datetime.date.today().year
2015
```

The component parts of today's date

You can also invoke the `date.isoformat` function and pass in today's date to display a much more user-friendly version of today's date, which is converted to a string by `isoformat`:

```
>>> datetime.date.isoformat(datetime.date.today())
'2015-05-31'
```

Today's date as a string

And then there's time, which none of us seem to have enough of. Can the *standard library* tell us what time it is? Yes. After importing the `time` module, call the `strftime` function and specify how you want the time displayed. In this case, we are interested in the current time's hours (`%H`) and minutes (`%M`) values in 24-hour format:

```
>>> import time
>>> time.strftime("%H:%M")
'23:55'
```

Good heavens! Is that the time?

How about working out the day of the week, and whether or not it's before noon? Using the `%A %p` specification with `strftime` does just that:

```
>>> time.strftime("%A %p")
'Sunday PM'
```

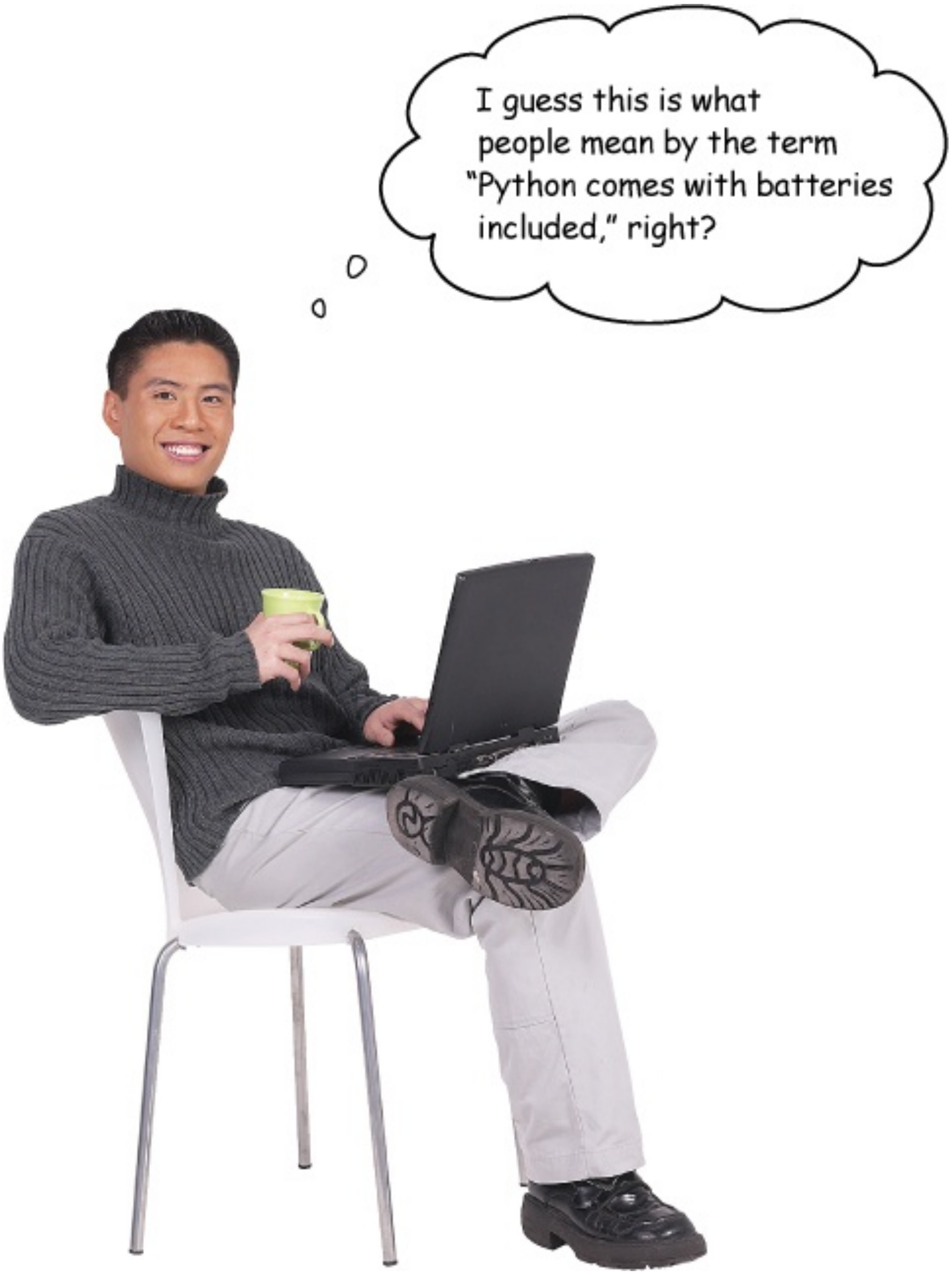
We've now worked out that it's five minutes to midnight on Sunday evening...time for bed, perhaps?

As a final example of the type of reusable functionality the *standard library* provides, imagine you have some HTML that you are worried might contain some potentially dangerous `<script>` tags. Rather than parsing the HTML to detect and remove the tags, why not encode all those troublesome angle brackets using the `escape` function from the `html` module? Or maybe you have some encoded HTML that you'd like to return to its original form? The `unescape` function can do that. Here are examples of both:

```
>>> import html
>>> html.escape("This HTML fragment contains a <script>script</script> tag.")
'This HTML fragment contains a &lt;script&gt;script&lt;/script&gt; tag.'
>>> html.unescape("I &hearts; Python's &lt;standard library&gt;.")
"I ♥ Python's <standard library>."
```

Converting to and from HTML encoded text

Batteries Included



Yes. That's what they mean.

As the *standard library* is *so* rich, the thinking is all you need to be **immediately productive** with the language is to have Python installed.

Unlike Christmas morning, when you open your new toy only to discover that it doesn't come with batteries, Python doesn't disappoint; it comes with everything you need to get going. And it’s not just the modules in the *standard library* that this thinking applies to: don’t forget the inclusion of IDLE, which provides a small, yet usable, IDE right out of the box.

All you have to do is code.

GEEK BITS

The standard library isn’t the only place you’ll find excellent importable modules to use with your code. The Python community also supports a thriving collection of third-party modules, some of which we’ll explore later in this book. If you want a preview, check out the community-run repository: *http://pypi.python.org*.

THERE ARE NO DUMB QUESTIONS

Q: **Q: How am I supposed to work out what any particular module from the standard library does?**

A: **A:** *.The Python documentation has all the answers on the standard library. Here’s the kicking-off point: https://docs.python.org/3/library/index.html*.

Data Structures Come Built-in

As well as coming with a top-notch *standard library*, Python also has some powerful built-in **data structures**. One of these is the **list**, which can be thought of as a very powerful *array*. Like arrays in many other languages, lists in Python are enclosed within square brackets (`[]`).

Like arrays, lists can hold data of any type.

The next three lines of code in our program (shown below) assign a *literal* list of odd numbers to a variable called `odds`. In this code, `odds` is *a list of integers*, but lists in Python can contain *any* data of *any* type, and you can even mix the types of data in a list (if that’s what you’re into). Note how the `odds` list extends over three lines, despite being a single statement. This is OK, as the interpreter won't decide a single statement has come to an end until it finds the closing bracket (`]`) that matches the opening one (`[`). Typically, **the end of the line marks the end of a statement in Python**, but there can be exceptions to this general rule, and multiline lists are just one of them (we'll meet the others later).

```
from datetime import datetime

odds = [ 1,  3,  5,  7,  9, 11, 13, 15, 17, 19,
        21, 23, 25, 27, 29, 31, 33, 35, 37, 39,
        41, 43, 45, 47, 49, 51, 53, 55, 57, 59 ]
    ...
```

This is a new variable, called "odds", which is assigned a list of odd numbers.

This is the list of odd numbers, enclosed in square brackets. This single statement extends over three lines, which is OK.

There are lots of things that can be done with lists, but we're going to defer any further discussion until a later chapter. All you need to know now is that this list now *exists*, has been *assigned* to the `odds` variable (thanks to the use of the **assignment operator**, `=`), and *contains* the numbers shown.

PYTHON VARIABLES ARE DYNAMICALLY ASSIGNED

Before getting to the next line of code, perhaps a few words are needed about variables, especially if you are one of those programmers who might be used to predeclaring variables with type information *before* using them (as is the case in statically typed programming languages).

Python comes with all the usual operators, including <, >, <=, >=, ==, !=, as well as the = assignment operator.

In Python, variables pop into existence the first time you use them, and **their type does not need to be predeclared**. Python variables take their type information from the type of the object they're assigned. In our program, the `odds` variable is assigned a list of numbers, so `odds` is a list in this case.

Let's look at another variable assignment statement. As luck would have it, this just so happens to also be the next line of code in our program.

Invoking Methods Obtains Results

The third line of code in our program is another **assignment statement**.

Unlike the last one, this one doesn't assign a data structure to a variable, but instead assigns the **result** of a method call to another new variable, called `right_this_minute`. Take another look at the third line of code:

Here's another variable being created and assigned a value.

```
from datetime import datetime

odds = [ 1,  3,  5,  7,  9, 11, 13, 15, 17, 19,
        21, 23, 25, 27, 29, 31, 33, 35, 37, 39,
        41, 43, 45, 47, 49, 51, 53, 55, 57, 59 ]

right_this_minute = datetime.today().minute

if right_this_minute in odds:
    print("This minute seems a little odd.")
else:
    print("Not an odd minute.")
```

This call generates a value to assign to the variable.

INVOKING BUILT-IN MODULE FUNCTIONALITY

The third line of code invokes a method called `today` that comes with the `datetime` submodule, which is *itself* part of the `datetime` module (we did say this naming strategy *was* a little confusing). You can tell `today` is being invoked due to the standard postfix parentheses: `()`.

You'll see more of the dot-notation syntax later in this book.

When `today` is invoked, it returns a "time object," which contains many pieces of information about the current time. These are the current time's **attributes**, which you can access via the customary **dot-notation** syntax. In this program, we are interested in the minute attribute, which we can access by appending `.minute` to the method invocation, as shown above. The resulting value is then assigned to the `right_this_minute` variable. You can think of this line of code as saying: *create an object that represents today's time, then extract the value of the minute attribute before assigning it to a variable.* It is tempting to *split* this single line of code into two lines to make it “easier to understand,” as follows:

First, determine the current time....

```
time_now = datetime.today()
right_this_minute = time_now.minute
```

...then extract the minute value.

You can do this (if you like), but most Python programmers prefer **not** to create the temporary variable (`time_now` in this example) *unless* it’s needed at some point later in the program.

Deciding When to Run Blocks of Code

At this stage we have a list of numbers called `odds`. We also have a minute value called `right_this_minute`. In order to work out whether the current minute value stored in `right_this_minute` is an odd number, we need some way of determining if it is in the `odds` list. But how do we do this?

It turns out that Python makes this type of thing very straightforward. As well as including all the usual comparison operators that you’d expect to find in any programming language (such as `>`, `<`, `>=`, `<=`, and so on), Python comes with a few “super” operators of its own, one of which is `in`.

The `in` operator checks if one thing is *inside* another. Take a look at the next line of code in our program, which uses the `in` operator to check whether `right_this_minute` is *inside* the `odds` list:

```
    ...
right_this_minute = datetime.today().minute

if right_this_minute in odds:
    print("This minute seems a little odd.")
    ...
```

This “if” statement will evaluate to either “True” or “False”.

The “in” operator is powerful. It can determine whether one thing is inside another.

The `in` operator returns either `True` or `False`. As you’d expect, if the value in `right_this_minute` is in `odds`, the `if` statement evaluates to `True`, and the block of code associated with the `if` statement executes.

Blocks in Python are easy to spot, as they are always indented.

In our program there are two blocks, which each contain a single call to the `print` function. This function can display messages on screen (and we'll see lots of uses of it throughout this book). When you enter this program code into the edit window, you may have noticed that IDLE helps keep you straight by indenting automatically. This is very useful, but do be sure to check that IDLE's indentation is what you want:

Here is one block of code. Note: the code is indented.

```
    ...
right_this_minute = datetime.today().minute

if right_this_minute in odds:
    print("This minute seems a little odd.")
else:
    print("Not an odd minute.")
```

The "print" function displays a message on standard output (i.e., your screen).

And here is another block of code. Note: it's indented, too.

Did you notice that there are no curly braces here?

What Happened to My Curly Braces?

If you are used to a programming language that uses curly braces (`{` and `}`) to delimit blocks of code, encountering blocks in Python for the first time can be disorienting, as Python doesn't use curly braces for this purpose. Python uses **indentation** to demarcate a block of code, which Python programmers prefer to call **suite** as opposed to *block* (just to mix things up a little).

It's not that curly braces don't have a use in Python. They do, but—as we'll see in Chapter 3—curly braces have more to do with delimiting data than they have to do with delimiting suites (i.e., *blocks*) of code.

Instead of referring to a code "block," Python programmers use the word "suite." Both names are used in practice, but the Python docs prefer "suite."

Suites within any Python program are easy to spot, as they are always indented. This helps your brain quickly identify suites when reading code. The other visual clue for you to look out for is the colon character (`:`), which is used to introduce a suite that's associated with any of Python's control statements (such as `if`, `else`, `for`, and the like). You'll see lots of examples of this usage as you progress through this book.

A COLON INTRODUCES AN INDENTED SUITE OF CODE

The colon (`:`) is important, in that it introduces a new suite of code that must be indented to the right. If you forget to indent your code after a colon, the interpreter raises an error.

Not only does the `if` statement in our example have a colon, the `else` has one, too. Here's all the code again:

```
from datetime import datetime

odds = [ 1,  3,  5,  7,  9, 11, 13, 15, 17, 19,
        21, 23, 25, 27, 29, 31, 33, 35, 37, 39,
        41, 43, 45, 47, 49, 51, 53, 55, 57, 59 ]

right_this_minute = datetime.today().minute

if right_this_minute in odds:
    print("This minute seems a little odd.")
else:
    print("Not an odd minute.")
```

Colons introduce indented suites.

We're nearly done. There's just one final statement to discuss.

What "else" Can You Have with "if"?

We are nearly done with the code for our example program, in that there is only one line of code left to discuss. It is not a very big line of code, but it’s an important one: the `else` statement that identifies the block of code that executes when the matching `if` statement returns a `False` value.

Take a closer look at the `else` statement from our program code, which we need to unindent to align with the `if` part of this statement:

```
if right_this_minute in odds:
    print("This minute seems a little odd.")
else:
    print("Not an odd minute.")
```

See the colon?

Did you spot that the “else” is unindented to align with the “if”?

It is a very common slip-up for Python newbies to forget the colon when first writing code.

Neither. Python spells it `elif`.

If you have a number of conditions that you need to check as part of an `if` statement, Python provides `elif` as well as `else`. You can have as many `elif` statements (each with its own suite) as needed.

Here's a small example that assumes a variable called `today` is previously assigned a string representing whatever today is:

```
if today == 'Saturday':
    print('Party!!')
elif today == 'Sunday':
    print('Recover.')
else:
    print('Work, work, work.')
```

Three individual suites: one for the "if", another for the "elif", and the final catch-all for the "else".

Suites Can Contain Embedded Suites

Any suite can contain any number of embedded suites, which also have to be indented. When Python programmers talk about embedded suites, they tend to talk about **levels of indentation**.

The initial level of indentation for any program is generally referred to as the *first* or (as is so common when it comes to counting with many programming languages) indentation level *zero*. Subsequent levels are referred to as the second, third, fourth, and so on (or level one, level two, level three, and so on).

Here's a variation on the today example code from the last page. Note how an embedded `if/else` has been added to the `if` statement that executes when `today` is set to '`Sunday`'. We're also assuming another variable called `condition` exists and is set to a value that expresses how you're currently feeling. We've indicated where each of the suites is, as well as at which level of indentation it appears:

This single line of code is a suite.

```
if today == 'Saturday':
    print('Party!')
elif today == 'Sunday':
    if condition == 'Headache':
        print('Recover, then rest.')
    else:
        print('Rest.')
else:
    print('Work, work, work.')
```

These four lines of code are a suite

These single lines of code are both suites.

This single line of code is a suite.

Indentation level zero

Indentation level one

Indentation level two

It is important to note that code at the same level of indentation is only related to other code at the same level of indentation if all the code appears *within the same suite*. Otherwise, they are in separate suites, and it does not matter that they share a level of indentation. The key point is that indentation is used to demarcate suites of code in Python.

What We Already Know

With the final few lines of code discussed, let's pause to review what the `odd.py` program has told us about Python:

BULLET POINTS

- Python comes with a built-in IDE called IDLE, which lets you create, edit, and run your Python code—all you need to do is type in your code, save it, and then press F5.

- IDLE interacts with the Python interpreter, which automates the compile-link-run process for you. This lets you concentrate on writing your code.
- The interpreter runs your code (stored in a file) from top to bottom, one line at a time. There is no notion of a `main()` function/method in Python.
- Python comes with a powerful standard library, which provides access to lots of reusable modules (of which `datetime` is just one example).
- There is a collection of standard data structures available to you when you're writing Python programs. The list is one of them, and is very similar in notion to an array.
- The type of a variable does not need to be declared. When you assign a value to a variable in Python, it dynamically takes on the type of the data it refers to.
- You make decisions with the `if`/`elif`/`else` statement. The `if`, `elif`, and `else` keywords precede blocks of code, which are known in the Python world as "suites."
- It is easy to spot suites of code, as they are always indented. Indentation is the only code grouping mechanism provided by Python.
- In addition to indentation, suites of code are also preceded by a colon (**:**). This is a syntactical requirement of the language.

Let's extend this program to do more.

It's true that we needed more lines to describe what this short program does than we actually needed to write the code. But this is one of the great strengths of Python: *you can get a lot done with a few lines of code*.

Review the list above once more, and then turn the page to make a start on seeing what our program's extensions will be.

Extending Our Program to Do More

Let's extend our program in order to learn a bit more Python.

At the moment, the program runs once, then terminates. Imagine that we want this program to execute more than once; let's say five times. Specifically, let's execute the "minute checking code" and the `if/else` statement five times, pausing for a random number of seconds between each message display (just to keep things interesting). When the program terminates, five messages should be on screen, as opposed to one.

Here's the code again, with the code we want to run multiple times circled:

Let's tweak the program to run this code a number of times.

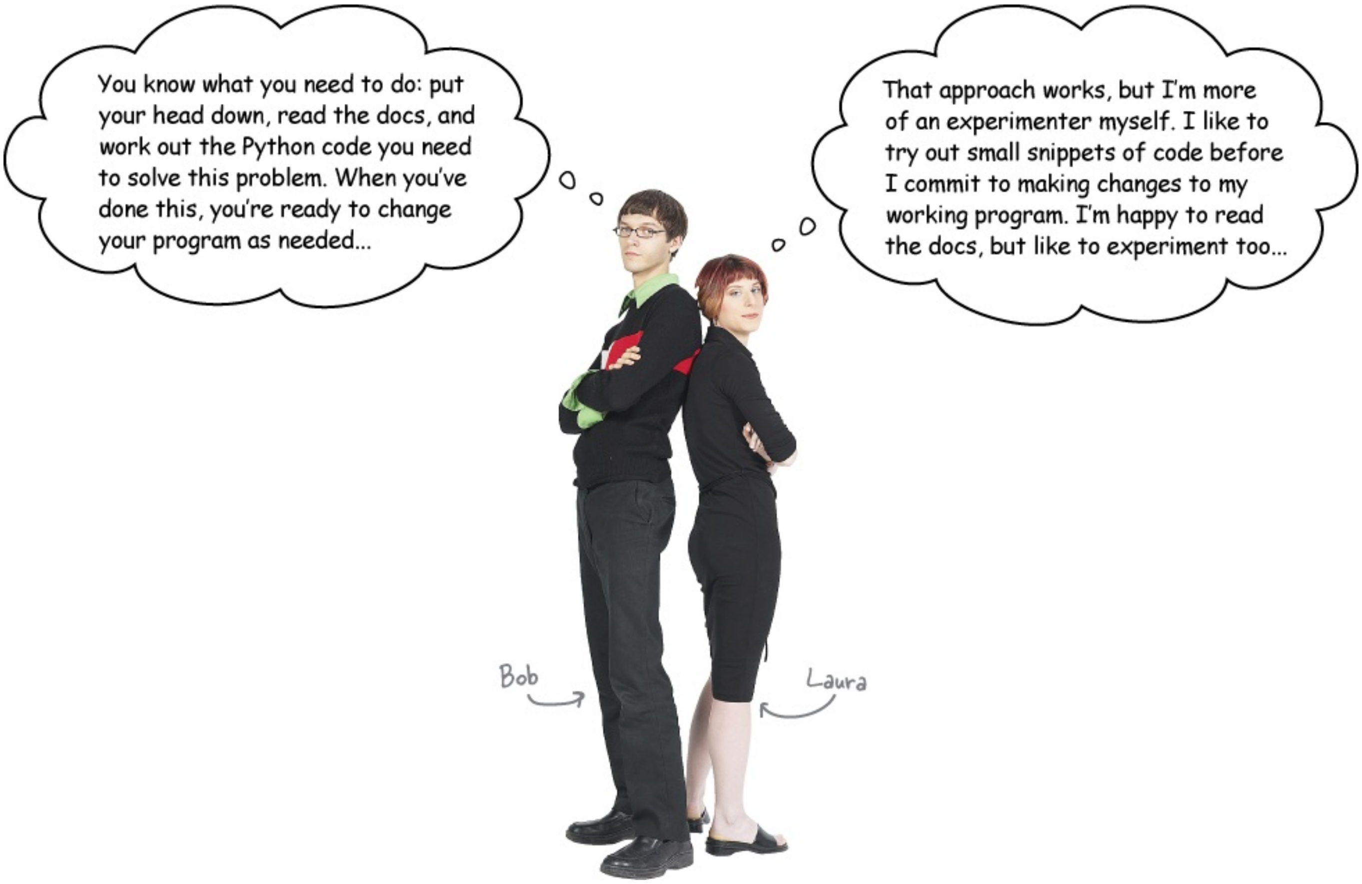
```
from datetime import datetime

odds = [ 1,  3,  5,  7,  9, 11, 13, 15, 17, 19,
        21, 23, 25, 27, 29, 31, 33, 35, 37, 39,
        41, 43, 45, 47, 49, 51, 53, 55, 57, 59 ]

right_this_minute = datetime.today().minute

if right_this_minute in odds:
    print("This minute seems a little odd.")
else:
    print("Not an odd minute.")
```

WHAT WE NEED TO DO:

1. **Loop over the encircled code.**
   A loop lets us iterate over any suite, and Python provides a number of ways to do just that. In this case (and without getting into why), we'll use Python's `for` loop to iterate.
2. **Pause execution.**
   Python's standard `time` module provides a function called `sleep` that can pause execution for an indicated number of seconds.
3. **Generate a random number.**
   Happily, another Python module, `random`, provides a function called `randint` that we can use to generate a random number. Let's use `randint` to generate a number between 1 and 60, then use that number to pause the execution of our program on each iteration.

We now know what we want to do. But is there a preferred way of going about making these changes?

What's the Best Approach to Solving This Problem?



BOTH APPROACHES WORK WITH PYTHON

You can follow *both* of these approaches when working with Python, but most Python programmers favor **experimentation** when trying to work out what code they need for a particular situation.

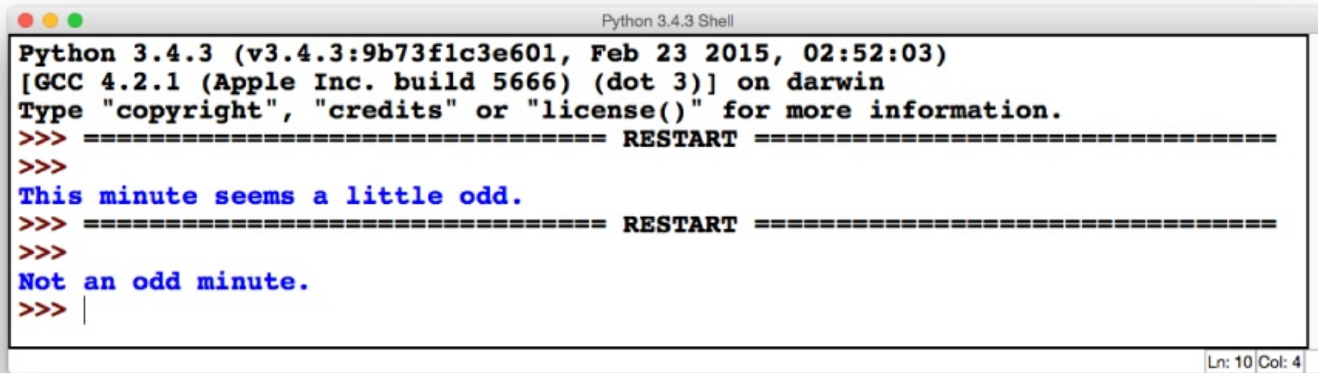
Experimenting at the >>> prompt helps you work out the code you need.

Don't get us wrong: we are not suggesting that Bob's approach is wrong and Laura's is right. It's just that Python programmers have both options available to them, and the Python Shell (which we met briefly at the start of this chapter) makes experimentation a natural choice for Python programmers.

Let's determine the code we need in order to extend our program, by experimenting at the >>> prompt.

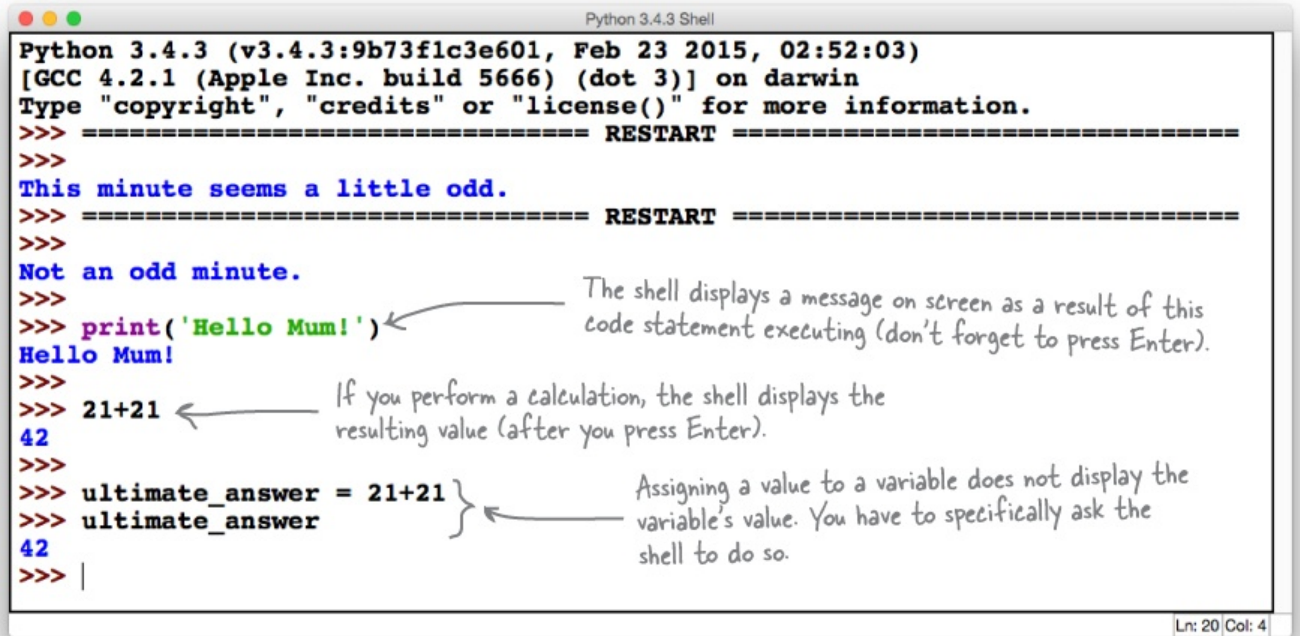
Returning to the Python Shell

Here's how the Python Shell looked the last time we interacted with it (yours might look a little different, as your messages may have appeared in an alternate order):



The Python Shell (or just "shell" for short) has displayed our program's messages, but it can do so much more than this. The >>> prompt allows you to enter any Python code statement and have it execute *immediately*. If the statement produces output, the shell displays it. If the statement results in a value, the shell displays the calculated value. If, however, you create a new variable and assign it a value, you need to enter the variable's name at the >>> prompt to see what value it contains.

Check out the example interactions, shown below. It is even better if you follow along and try out these examples at *your* shell. Just be sure to press the *Enter* key to terminate each program statement, which also tells the shell to execute it *now*:



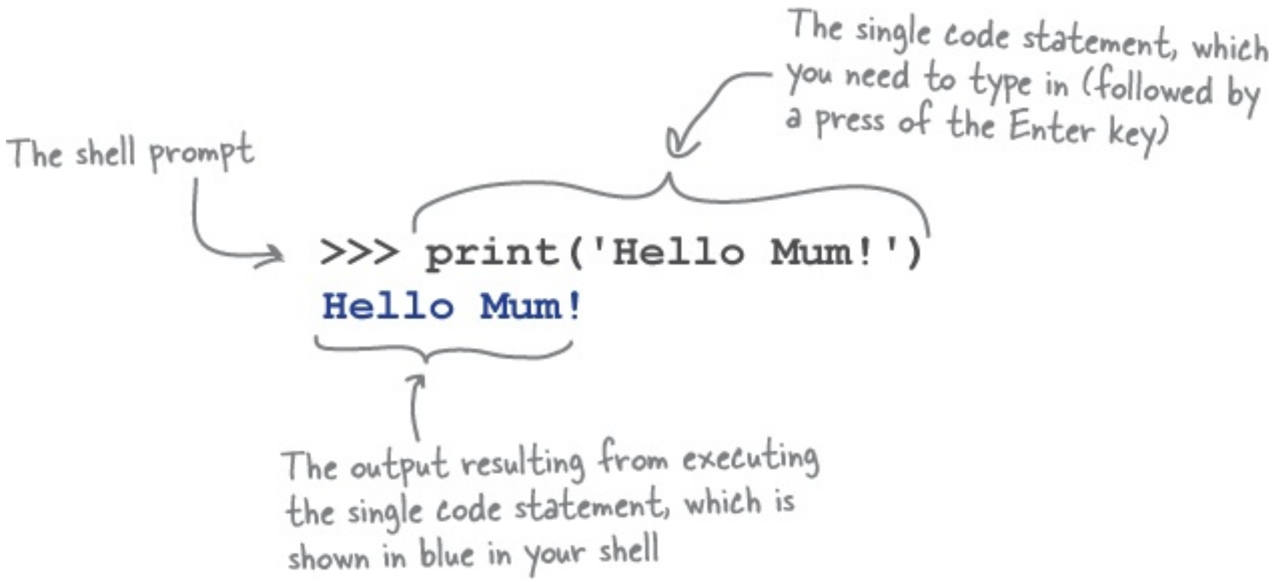
Experimenting at the Shell

Now that you know you can type a single Python statement into the >>> prompt and have it execute immediately, you can start to work out the code you need to extend your program.

Here's what you need your new code to do:

☐	**Loop** a specified number of times. We've already decided to use Python's `for` loop here.
☐	**Pause** the program for a specified number of seconds. The `sleep` function from the standard library's `time` module can do this.
☐	**Generate** a random number between two provided values. The `randint`function from the `random` module will do the trick.

Rather than continuing to show you complete IDLE screenshots, we're only going to show you the >>> prompt and any displayed output. Specifically, from this point onward, you'll see something like the following instead of the earlier screenshots:



Over the next few pages, we're going to experiment to figure out how to add the three features listed above. We'll *play* with code at the `>>>` prompt until we determine exactly the statements we need to add to our program. Leave the `odd.py` code as is for now, then make sure the shell window is active by selecting it. The cursor should be blinking away to the right of the `>>>`, waiting for you to type some code.

Flip the page when you're ready. Let the experiments begin.

Iterating Over a Sequence of Objects

We said earlier that we were going to employ Python's `for` loop here. The `for` loop is *perfect* for controlling looping when you know ahead of time how many iterations you need. (When you don't know, we recommend the `while` loop, but we'll save discussing the details of this alternate looping construct until we actually need it). At this stage, all we need is `for`, so let's see it in action at the `>>>` prompt.

Use "for" when looping a known number of times.

We present three typical uses of `for`. Let's see which one best fits our needs.

Usage example 1. This `for` loop, below, takes a list of numbers and iterates once for each number in the list, displaying the current number on screen. As it does so, the `for` loop assigns each number in turn to a *loop iteration variable*, which is given the name `i` in this code.

As this code is more than a single line, the shell indents automatically for you when you press Enter after the colon. To signal to the shell that you are done entering code, press Enter *twice* at the end of the loop's suite:

```
>>> for i in [1, 2, 3]:
        print(i)

1
2
3
```

We used "i" as the loop iteration variable in this example, but we could've called it just about anything. Having said that, "i", "j", and "k" are incredibly popular among most programmers in this situation.

As this is a suite, you need to press the Enter key TWICE after typing in this code in order to terminate the statement and see it execute.

Note the *indentation* and *colon*. Like `if` statements, the code associated with a `for` statement needs to be **indented**.

A sequence is an ordered collection of objects.

Usage example 2. This `for` loop, below, iterates over a string, with each character in the string being processed during each iteration. This works because a string in Python is a **sequence**. A sequence is an ordered collection of objects (and we'll see lots of examples of sequences in this book), and every sequence in Python can be iterated over by the interpreter.

```
>>> for ch in "Hi!":
        print(ch)

H
i
!
```

Python is smart enough to work out that this string should be iterated over one-character at a time (and that's why we used "ch" as the loop variable name here).

Nowhere did you have to tell the `for` loop *how big the string is.* Python is smart enough to work out when the string *ends*, and arranges to terminate (i.e., end) the `for` loop on your behalf when it exhausts all the objects in the sequence.

Iterating a Specific Number of Times

In addition to using `for` to iterate over a sequence, you can be more exact and specify a number of iterations, thanks to the built-in function called `range`.

Let's look at another usage example that showcases using `range`.

Usage example 3. In its most basic form, `range` accepts a single integer argument that dictates how many times the `for` loop runs (we'll see other uses of `range` later in this book). In this loop, we use `range` to generate a list of numbers that are assigned one at a time to the `num` variable:

```
>>> for num in range(5):
            print('Head First Rocks!')

Head First Rocks!
Head First Rocks!
Head First Rocks!
Head First Rocks!
Head First Rocks!
```

We asked for a range of five numbers, so we iterated five times, which results in five messages. Remember: press Enter twice to run code that has a suite.

The `for` loop *didn't use* the `num` loop iteration variable *anywhere* in the loop's suite. This did not raise an error, which is OK, as it is up to you (the programmer) to decide whether or not `num` needs to be processed further in the suite. In this case, doing nothing with `num` is fine.

Indeed we are. Task #1 is complete.

The three usage examples show that Python's `for` loop is what we need to use here, so let's take the technique shown in **Usage example 3** and use it to iterate a *specified number of times* using a `for` loop.

Applying the Outcome of Task #1 to Our Code

Here's how our code looked in IDLE's edit window *before* we worked on Task #1:

odd.py - /Users/paul/Desktop/_NewBook/ch01/odd.py (3.5.1)

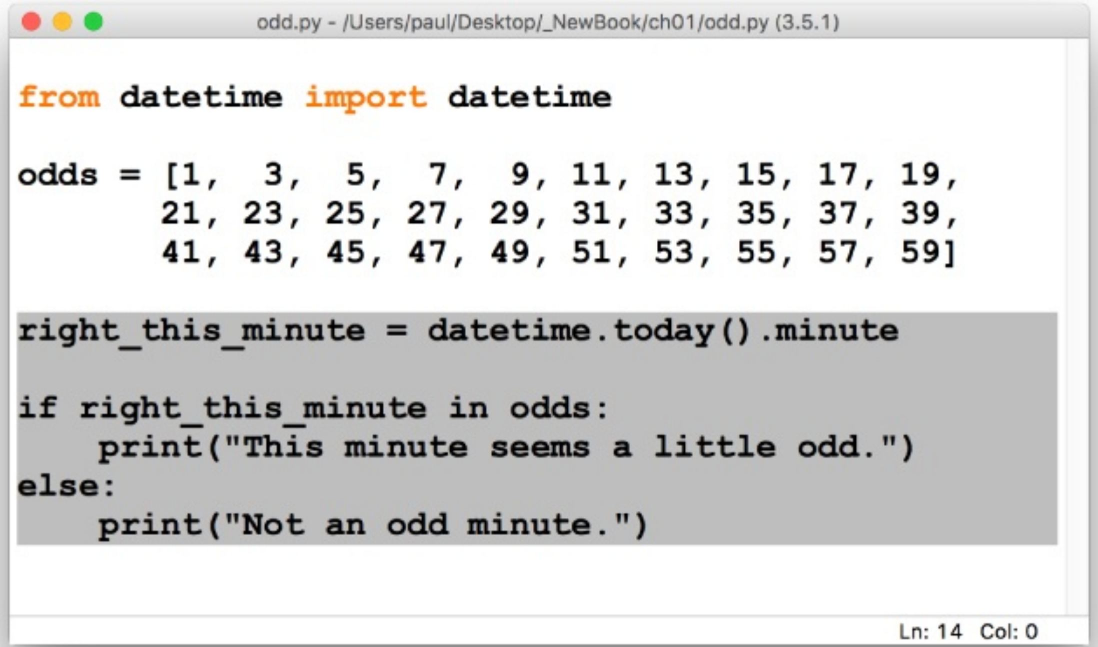
```
from datetime import datetime

odds = [1,  3,  5,  7,  9, 11, 13, 15, 17, 19,
       21, 23, 25, 27, 29, 31, 33, 35, 37, 39,
       41, 43, 45, 47, 49, 51, 53, 55, 57, 59]

right_this_minute = datetime.today().minute

if right_this_minute in odds:
    print("This minute seems a little odd.")
else:
    print("Not an odd minute.")
```

Ln: 14 Col: 0

This is the code we want to repeat.

You now know that you can use a `for` loop to repeat the five lines of code at the bottom of this program five times. The five lines will need to be **indented** under the `for` loop, as they are going to form the loop's suite. Specifically, each line of code needs to be indented *once*. However, don't be tempted to perform this action on each individual line. Instead, let IDLE indent the entire suite for you *in one go*.

Begin by using your mouse to select the lines of code you want to indent:



Use your mouse to select the lines of code you want to indent.

Indent Suites with Format...Indent Region

With the five lines of code selected, choose *Indent Region* from the *Format* menu in IDLE’s edit window. The entire suite moves to the right by one indentation level:

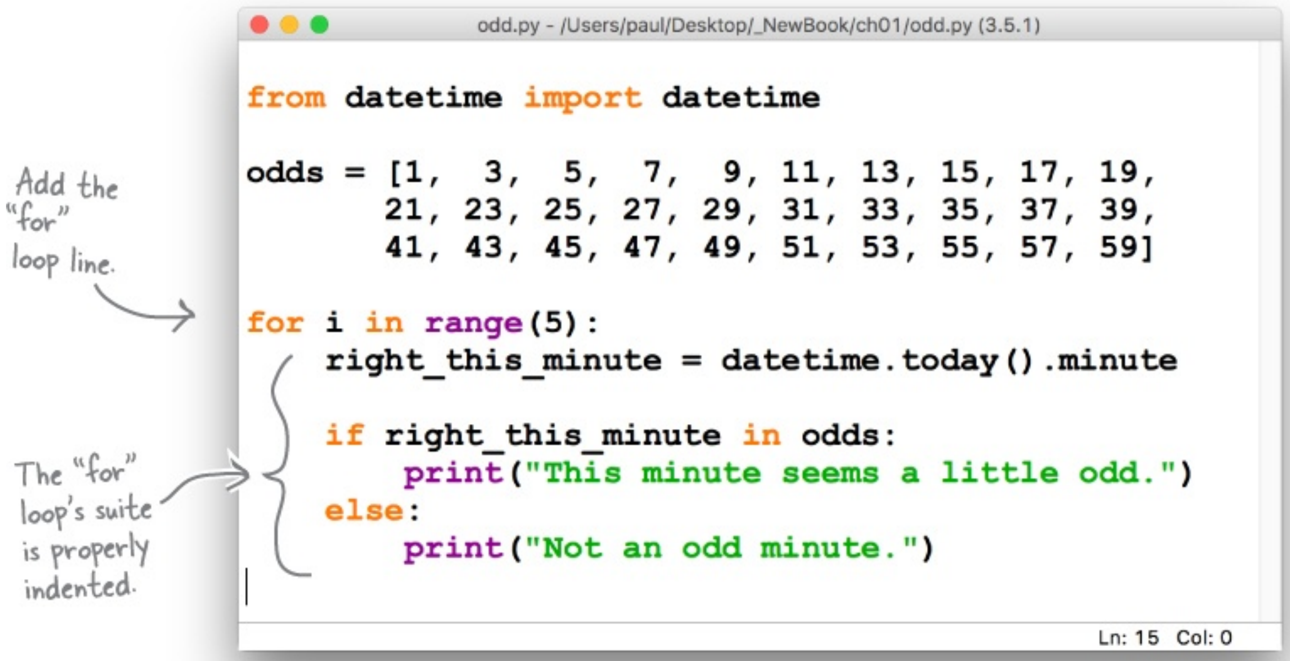
odd.py - /Users/paul/Desktop/_NewBook/ch01/odd.py (3.5.1)

```
from datetime import datetime

odds = [1,  3,  5,  7,  9, 11, 13, 15, 17, 19,
       21, 23, 25, 27, 29, 31, 33, 35, 37, 39,
       41, 43, 45, 47, 49, 51, 53, 55, 57, 59]

    right_this_minute = datetime.today().minute

    if right_this_minute in odds:
        print("This minute seems a little odd.")
    else:
        print("Not an odd minute.")

```

Ln: 14   Col: 0

The Indent Region option from the Format menu indents all of the selected lines of code in one go.

Note that IDLE also has a *Dedent Region* menu option, which unindents suites, and that both the *Indent* and *Dedent* menu commands have keyboard shortcuts, which differ slightly based on the operating system you are running. Take the time to learn the keyboard shortcuts that your system uses *now* (as you'll use them all the time). With the suite indented, it's time to add the `for` loop:




```
from datetime import datetime

odds = [1,  3,  5,  7,  9, 11, 13, 15, 17, 19,
       21, 23, 25, 27, 29, 31, 33, 35, 37, 39,
       41, 43, 45, 47, 49, 51, 53, 55, 57, 59]

for i in range(5):
    right_this_minute = datetime.today().minute

    if right_this_minute in odds:
        print("This minute seems a little odd.")
    else:
        print("Not an odd minute.")
```

Arranging to Pause Execution

Let's remind ourselves of what we need this code to do:

☑	**Loop** a specified number of times.
☐	**Pause** the program for a specified number of seconds.
☐	**Generate** a random number between two provided values.

We're now ready to return to the shell and try out some more code to help with the second task: *pause the program for a specified number of seconds*.

However, before we do that, recall the opening line of our program, which imported a specifically named function from a specifically named module:

```
from datetime import datetime
```

This usage of "import" brings in the named function to your program. You can then invoke it without using the dot-notation syntax.

This is one way to import a function into your program. Another equally common technique is to import a module *without* being specific about the function you want to use. Let's use this second technique here, as it will appear in many Python programs you'll come across.

As mentioned earlier in this chapter, the `sleep` function can pause execution for a specified number of seconds, and is provided by the standard library's `time` module. Let's **import** the module *first*, without mentioning `sleep` just yet:

```
>>> import time
>>>
```

This tells the shell to import the "time" module.

When the `import` statement is used as it is with the `time` module above, you get access to the facilities provided by the module without anything expressly *named* being imported into your program's code. To access a function provided by a module imported in this way, use the dot-notation syntax to name it, as shown here:

This is the number of seconds to sleep for.

Name the module first (before the period).

```
>>> time.sleep(5)
>>>
```

Specify the function you want to invoke (after the period).

Note that when you invoke `sleep` in this way, the shell pauses for five seconds before the >>> prompt reappears. Go ahead, and *try it now.*

Importation Confusion

That's a great question.

Just to be clear, there aren't *two* importation mechanisms in Python, as there is only *one* `import` statement. However, the `import` statement can be used *in two ways*.

The first, which we initially saw in our example program, imports a named function into our program's **namespace**, which then allows us to invoke the function as necessary without having to *link* the function back to the imported module. (The notion of a namespace is important in Python, as it defines the context within which your code runs. That said, we're going to wait until a later chapter to explore namespaces in detail).

In our example program, we use the first importation technique, then invoke the `datetime` function as `datetime()`, *not* as `datetime.datetime()`.

The second way to use `import` is to just import the module, as we did when experimenting with the `time` module. When we import this way, we have to use the dot-notation syntax to access the module's functionality, as we did with `time.sleep()`.

THERE ARE NO DUMB QUESTIONS

Q: **Q: Is there a correct way to use `import`?**

A: **A:** *It can often come down to personal preference, as some programmers like to be very specific, while others don't. However, there is a situation that occurs when two modules (we'll call them* `A` *and* `B`*) have a function of the same name, which we'll call* `F`*. If you put* `from A import F` *and* `from B import F` *in your code, how is Python to know which* `F` *to invoke when you call* `F()`*? The only way you can be sure is to use the nonspecific* `import` *statement (that is, put* `import A` *and* `import B` *in your code), then invoke the specific* `F` *you want using either* `A.F()` *or* `B.F()` *as needed. Doing so negates any confusion.*

Generating Random Integers with Python

Although it is tempting to add `import time` to the top of our program, then call `time.sleep(5)` in the `for` loop's suite, we aren't going to do this right now. We aren't done with our experimentations. Pausing for five seconds isn't enough; we need to be able to pause for a *random amount of time*. With that in mind, let's remind ourselves of what we've done, and what remains:

	Loop a specified number of times.
	Pause the program for a specified number of seconds.

☐	**Generate** a random number between two provided values.

Once we have this last task completed, we can get back to confidently changing our program to incorporate all that we've learned from our experimentations. But we're not there yet—let's look at the last task, which is to generate a random number.

As with sleeping, the *standard library* can help here, as it includes a module called `random`. With just this piece of information to guide us, let's experiment at the shell:

```
>>> import random

>>>
```

Use "dir" to query an object.

Now what? We could look at the Python docs or consult a Python reference book...but that involves taking our attention away from the shell, even though it might only take a few moments. As it happens, the shell provides some additional functions that can help here. These functions aren't meant to be used within your program code; they are designed for use at the >>> prompt. The first is called `dir`, and it displays all the **attributes** associated with anything in Python, including modules:

Buried in the middle of this long list is the name of the function we need.

```
>>> dir(random)
['BPF', 'LOG4', 'NV_MAGICCONST', 'RECIP_BPF',
'Random',    ...    'randint', 'random', 'randrange',
'sample', 'seed', 'setstate', 'shuffle', 'triangular',
'uniform', 'vonmisesvariate', 'weibullvariate']
```

This is an abridged list. What you'll see on your screen is much longer.

This list has a lot in it. Of interest is the `randint()` function. To learn more about `randint`, let's ask the shell for some **help**.

Asking the Interpreter for Help

Once you know the name of something, you can ask the shell for **help**. When you do, the shell displays the section from the Python docs related to the name you're interested in.

Let's see this mechanism in action at the `>>>` prompt by asking for **help** with the `randint` function from the `random` module:

Use "help" to read the Python docs.

Ask for help at the >>> prompt...

```
>>> help(random.randint)
Help on method randint in module random:

randint(a, b) method of random.Random instance
    Return random integer in range [a, b], including
    both end points.
```

...and see the associated documentation right in the shell.

GEEK BITS

You can recall the last command(s) typed into the IDLE >>> prompt by typing Alt-P when using *Linux* or *Windows*. On *Mac OS X*, use Ctrl-P. Think of the "P" as meaning "previous."

A quick read of the displayed docs for the `randint` function confirms what we need to know: if we provide two integers to `randint`, we get back a random integer from the resulting inclusive range.

A few final experiments at the `>>>` prompt show the `randint` function in action:

```
>>> random.randint(1,60)
27
>>> random.randint(1,60)
34
>>> random.randint(1,60)
46
```

If you're following along, what you'll see on your screen will vary, as the integers returned by "randint" are generated randomly.

Because you imported the "random" module using "import random", you need to remember to prefix the call to "randint" with the module name and a dot. So it's "random.randint()" and not "randint()".

With this, you are now in a position to place a satisfying check mark against the last of our tasks, as you now know enough to generate a random number between two provided values:

☑	**Generate** a random number between two provided values.

It's time to return to our program and make our changes.

Reviewing Our Experiments

Before you forge ahead and change your program, let's quickly review the outcome of our shell experiments.

We started by writing a `for` loop, which iterated five times:

```
>>> for num in range(5):
        print('Head First Rocks!')

Head First Rocks!
Head First Rocks!
Head First Rocks!
Head First Rocks!
Head First Rocks!
```

We asked for a range of five numbers, so we iterated five times, which results in five messages.

Then we used the `sleep` function from the `time` module to pause execution of our code for a specified number of seconds:

```
>>> import time
>>> time.sleep(5)
```

The shell imports the "time" module, letting us invoke the "sleep" function.

And then we experimented with the `randint` function (from the `random` module) to generate a random integer from a provided range:

```
>>> import random
>>> random.randint(1,60)
12
>>> random.randint(1,60)
42
>>> random.randint(1,60)
17
```

Note: different integers are generated once more, as "randint" returns a different random integer each time it's invoked.

We can now put all of this together and change our program.

Let's remind ourselves of what we decided to do earlier in this chapter: have our program iterate, executing the "minute checking code" and the `if/else` statement five times, and pausing for a random number of seconds between each iteration. This should result in five messages appearing on screen before the program terminates.

CODE EXPERIMENTS MAGNETS

Based on the specification at the bottom of the last page, as well as the results of our experimentations, we went ahead and did some of the required work for you. But, as we were arranging our code magnets on the fridge (don't ask) someone slammed the door, and now some of our code's all over the floor.

Your job is to put everything back together, so that we can run the new version of our program and confirm that it's working as required.

Decide which code magnet goes in each of the dashed-line locations.

```
from datetime import datetime

..................................
..................................

odds = [ 1,  3,  5,  7,  9, 11, 13, 15, 17, 19,
        21, 23, 25, 27, 29, 31, 33, 35, 37, 39,
        41, 43, 45, 47, 49, 51, 53, 55, 57, 59 ]

..................................
    right_this_minute = datetime.today().minute
    if right_this_minute in odds:
        print("This minute seems a little odd.")
    else:
        print("Not an odd minute.")
    wait_time = ..................................
    ........................ ( ........................ )
```

Where do all these go?

```
time.sleep
import time
wait_time
import random
for i in range(5):
random.randint(1, 60)
```

CODE EXPERIMENTS MAGNETS SOLUTION

Based on the specification from earlier, as well as the results of our experimentations, we went ahead and did some of the required work for you. But, as we were arranging our code magnets on the fridge (don't ask) someone slammed the door, and now some of our code's all over the floor.

Your job was to put everything back together, so that we could run the new version of our program and confirm that it's working as required.

You don't have to put your imports at the top of your code, but it is a well-established convention among Python programmers to do so.

```
from datetime import datetime

import random
import time

odds = [ 1,  3,  5,  7,  9, 11, 13, 15, 17, 19,
        21, 23, 25, 27, 29, 31, 33, 35, 37, 39,
        41, 43, 45, 47, 49, 51, 53, 55, 57, 59 ]

for i in range(5):
    right_this_minute = datetime.today().minute
    if right_this_minute in odds:
        print("This minute seems a little odd.")
    else:
        print("Not an odd minute.")
    wait_time = random.randint(1, 60)
    time.sleep(wait_time)
```

The "for" loop iterates EXACTLY five times.

All of this code is indented under the "for" statement, as it is all part of the "for" statement's suite. Remember: Python does not use curly braces to delimit suites; it uses indentation instead.

The "randint" function provides a random integer that is assigned to a new variable called "wait_time", which...

...is then used in the call to "sleep" to pause the program's execution for a random number of seconds.

TEST DRIVE

Let's try running our upgraded program in IDLE to see what happens. Change your version of `odd.py` as needed, then save a copy of your new program as `odd2.py`. When you're ready, press F5 to execute your code.

When you press F5 to run this code...

odd2.py - /Users/Paul/Desktop/_NewBook/ch01/odd2.py (3.4.3)

```
from datetime import datetime

import random
import time

odds = [ 1,  3,  5,  7,  9, 11, 13, 15, 17, 19,
        21, 23, 25, 27, 29, 31, 33, 35, 37, 39,
        41, 43, 45, 47, 49, 51, 53, 55, 57, 59 ]

for i in range(5):
    right_this_minute = datetime.today().minute
    if right_this_minute in odds:
        print("This minute seems a little odd.")
    else:
        print("Not an odd minute.")
    wait_time = random.randint(1, 60)
    time.sleep(wait_time)
```

Ln: 19 Col: 0

...you should see output similar to this. Just remember that your output will differ, as the random numbers your program generates most likely won't match ours.

Python 3.4.3 Shell

```
>>> ================================ RESTART ================================
>>>
This minute seems a little odd.
This minute seems a little odd.
Not an odd minute.
Not an odd minute.
Not an odd minute.
>>>
```

Ln: 25 Col: 4

Don't worry if you see a different list of messages than those shown here. You should see five messages, as that's how many times the loop code runs.

Updating What We Already Know

With `odd2.py` working, let's pause once more to review the new things we're learned about Python from these last 15 pages:

BULLET POINTS

- When trying to determine the code that they need to solve a particular problem, Python programmers often favor experimenting with code snippets at the shell.
- If you're looking at the >>> prompt, you're at the Python Shell. Go ahead: type in a single Python statement and see what happens when it runs.
- The shell takes your line of code and sends it to the interpreter, which then executes it. Any results are returned to the shell and are then displayed on screen.
- The `for` loop can be used to iterate a fixed number of times. If you know ahead of time how many times you need to loop, use `for`.
- When you don't know ahead of time how often you're going to iterate, use Python's `while` loop (which we have yet to see, but—don't worry—we will see it in action later).
- The `for` loop can iterate over any sequence (like a list or a string), as well as execute a fixed number of times (thanks to the `range` function).
- If you need to pause the execution of your program for a specified number of seconds, use the `sleep` function provided by the standard library's `time`module.
- You can import a specific function from a module. For example, `from time import sleep` imports the `sleep` function, letting you invoke it without qualification.
- If you simply import a module—for example, `import time`—you then need to qualify the usage of any of the module's functions with the module name, like so: `time.sleep()`.
- The `random` module has a very useful function called `randint` that generates a random integer within a specified range.
- The shell provides two interactive functions that work at the >>> prompt. The `dir` function lists an object's attributes, whereas `help` provides access to the Python docs.

THERE ARE NO DUMB QUESTIONS

Q: **Q: Do I have to remember all this stuff?**

A: **A:** *No, and don't freak out if your brain is resisting the insertion of everything seen so far. This is only the first chapter, and we've designed it to be a quick introduction to the world of Python programming. If you're getting the gist of what's going on with this code, then you're doing fine.*

A Few Lines of Code Do a Lot

It is, but we are on a roll here.

It's true we've only touched on a small amount of the Python language so far. But what we've looked at has been very useful.

What we've seen so far helps to demonstrate one of Python's big selling points: *a few lines of code do a lot*. Another of the language's claims to fame is this: *Python code is easy to read.*

In an attempt to prove just how easy, we present on the next page a completely different program that you already know enough about Python to understand.

Who's in the mood for a nice, cold beer?

Coding a Serious Business Application

With a tip of the hat to *Head First Java*, let's take a look at the Python version of that classic's first serious application: the beer song.

Shown below is a screenshot of the Python version of the beer song code. Other than a slight variation on the usage of the `range` function (which we'll discuss in a bit), most of this code should make sense. The IDLE edit window contains the code, while the tail end of the program's output appears in a shell window:

beersong.py - /Users/Paul/Desktop/_NewBook/ch01/beersong.py (3.4.3)

```python
word = "bottles"
for beer_num in range(99, 0, -1):
    print(beer_num, word, "of beer on the wall.")
    print(beer_num, word, "of beer.")
    print("Take one down.")
    print("Pass it around.")
    if beer_num == 1:
        print("No more bottles of beer on the wall.")
    else:
        new_num = beer_num - 1
        if new_num == 1:
            word = "bottle"
        print(new_num, word, "of beer on the wall.")
    print()
```

Running this code produces this output in the shell.

Python 3.4.3 Shell

```
3 bottles of beer on the wall.
3 bottles of beer.
Take one down.
Pass it around.
2 bottles of beer on the wall.

2 bottles of beer on the wall.
2 bottles of beer.
Take one down.
Pass it around.
1 bottle of beer on the wall.

1 bottle of beer on the wall.
1 bottle of beer.
Take one down.
Pass it around.
No more bottles of beer on the wall.

>>>
```

Ln: 660 Col: 12

DEALING WITH ALL THAT BEER...

With the code shown above typed into an IDLE edit window and saved, pressing F5 produces a lot of output in the shell. We've only shown a little bit of the resulting output in the window on the right, as the beer song starts with 99 bottles of beer on the wall and counts down until there's no more beer. In fact, the only real twist in this code is how it handles this "counting down," so let's take a look at how that works before looking at the program's code in detail.

Python Code Is Easy to Read

There isn't one!

When most programmers new to Python first encounter code like that of the beer song, they assume that something's got to give somewhere else.

There has to be a catch, doesn't there?

No, there doesn't. It's not by accident that Python code is easy to read: the language was designed with that specific goal in mind. *Guido van Rossum*, the language's creator, wanted to create a powerful programming tool that produced code that was easy to maintain, which meant code created in Python has to be easy to read, too.

Is Indentation Driving You Crazy?

Indentation takes time to get used to.

Don't worry. Everyone coming to Python from a "curly-braced language" struggles with indentation *at first*. But it does get better. After a day or two of working with Python, you'll hardly notice you're indenting your suites.

One problem that some programmers do have with indentation occurs when they mix *tabs* with *spaces*. Due to the way the interpreter counts **whitespace**, this can lead to problems, in that the code "looks fine" but refuses to run. This is frustrating when you're starting out with Python.

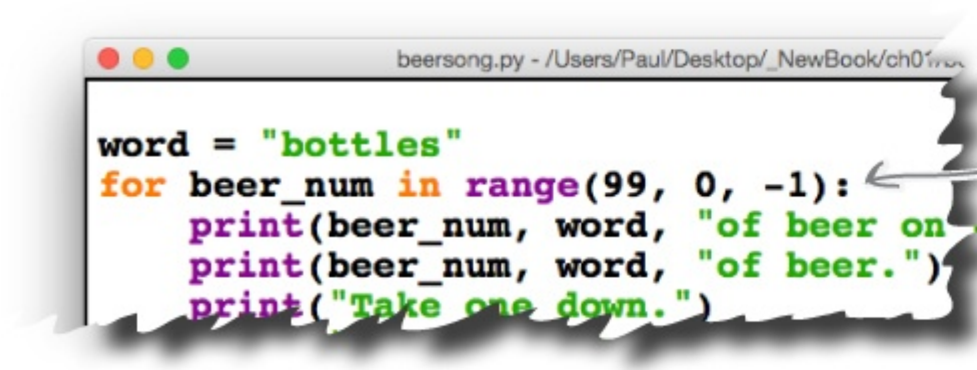
Our advice: *don't mix tabs with spaces in your Python code*.

In fact, we'd go even further and advise you to configure your editor to replace a tap of the *Tab* key with *four spaces* (and while you're at it, automatically remove any trailing whitespace, too). This is the well-established convention among many Python programmers, and you should follow it, too. We'll have more to say about dealing with indentation at the end of this chapter.

GETTING BACK TO THE BEER SONG CODE

If you take a look at the invocation of `range` in the beer song, you'll notice that it takes *three* arguments as opposed to just one (as in our first example program).

Take a closer look, and without looking at the explanation on the next page, see if you can work out what's going on with this call to `range`:



This is new: the call to "range" takes three arguments, not one.

Asking the Interpreter for Help on a Function

Recall that you can use the shell to ask for **help** with anything to do with Python, so let's ask for some help with the `range` function.

When you do this in IDLE, the resulting documentation is more than a screen's worth and it quickly scrolls off the screen. All you need to do is scroll back in the window to where you asked the shell for help (as that's where the interesting stuff about `range` is):

```
>>> help(range)
Help on class range in module builtins:

class range(object)
 |   range(stop) -> range object
 |   range(start, stop[, step]) -> range object
 |
 |   Return a sequence of numbers from start to stop by step.
        ...
```

The "range" function can be invoked in one of two ways.

This looks like it will give us what we need here.

STARTING, STOPPING, AND STEPPING

As `range` is not the only place you'll come across **start**, **stop**, and **step**, let's take a moment to describe what each of these means, before looking at some representative examples (on the next page):

1. **The START value lets you control from WHERE the range begins.** So far, we've used the single-argument version of `range`, which—from the documentation—expects a value for **stop** to be provided. When no other value is provided, `range` defaults to using `0` as the **start** value, but you can set it to a value of your choosing. When you do, you *must* provide a value for **stop**. In this way, `range` becomes a multi-argument invocation.
2. **The STOP value lets you control WHEN the range ends.** We've already seen this in use when we invoked `range(5)` in our code. Note that the range that's generated *never* contains the **stop** value, so it's a case of up-to-but-not-including **stop**.
3. **The STEP value lets you control HOW the range is generated.** When specifying **start** and **stop** values, you can also (optionally) specify a value for **step**. By default, the **step** value is `1`, and this tells `range` to

generate each value with a *stride* of `1`; that is, 0, 1, 2, 3, 4, and so on. You can set **step** to any value to adjust the stride taken. You can also set **step** to a negative value to adjust the *direction* of the generated range.

Experimenting with Ranges

Now that you know a little bit about **start**, **stop**, and **step**, let's experiment at the shell to learn how we can use the `range` function to produce many different ranges of integers.

To help see what's going on, we use another function, `list`, to transform `range`'s output into a human-readable list that we can see on screen:

```
>>> range(5)
range(0, 5)
```

This is how we used "range" in our first program.

```
>>> list(range(5))
[0, 1, 2, 3, 4]
```

Feeding the output from "range" to "list" produces a list.

```
>>> list(range(5, 10))
[5, 6, 7, 8, 9]
```

We can adjust the START and STOP values for "range".

It is also possible to adjust the STEP value.

```
>>> list(range(0, 10, 2))
[0, 2, 4, 6, 8]
```

```
>>> list(range(10, 0, -2))
[10, 8, 6, 4, 2]
```

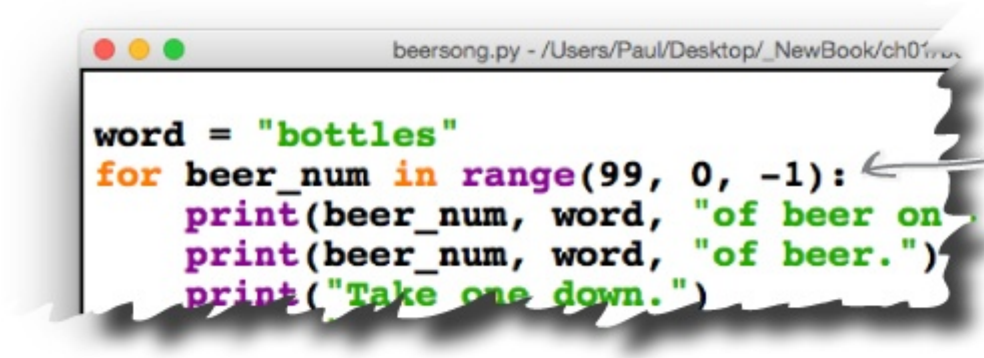
Things get really interesting when you adjust the range's direction by negating the STEP value.

```
>>> list(range(10, 0, 2))
[]
```

Python won't stop you from being silly. If your START value is bigger than your STOP value, and STEP is positive, you get back nothing (in this case, an empty list).

```
>>> list(range(99, 0, -1))
[99, 98, 97, 96, 95, 94, 93, 92,  ...  5, 4, 3, 2, 1]
```

After all of our experimentations, we arrive at a `range` invocation (shown last, above) that produces a list of values from 99 down to 1, which is exactly what the beer song's `for` loop does:



The call to "range" takes three arguments: start, stop, and step.

SHARPEN YOUR PENCIL

Here again is the beer code, which has been spread out over the entire page so that you can **concentrate** on each line of code that makes up this "serious business application."

Grab your pencil and, in the spaces provided, write in what you thought each line of code does. Be sure to attempt this yourself *before* looking at what we came up with on the next page. We've got you started by doing the first line of code for you.

```
word = "bottles"

for beer_num in range(99, 0, -1):

    print(beer_num, word, "of beer on the wall.")

    print(beer_num, word, "of beer.")

    print("Take one down.")

    print("Pass it around.")

    if beer_num == 1:

        print("No more bottles of beer on the wall.")

    else:

        new_num = beer_num - 1

        if new_num == 1:

            word = "bottle"

        print(new_num, word, "of beer on the wall.")

    print()
```

Assign the value "bottles" (a string) to a new variable called "word".

SHARPEN YOUR PENCIL SOLUTION

Here again is the beer code, which has been spread out over the entire page so that you can **concentrate** on each line of code that makes up this "serious business application."

You were to grab your pencil and then, in the spaces provided, write in what you thought each line of code does. We did the first line of code for you to get you started.

How did you get on? Are your explanations similar to ours?

```
word = "bottles"

for beer_num in range(99, 0, -1):

    print(beer_num, word, "of beer on the wall.")

    print(beer_num, word, "of beer.")

    print("Take one down.")

    print("Pass it around.")

    if beer_num == 1:

        print("No more bottles of beer on the wall.")

    else:

        new_num = beer_num - 1

        if new_num == 1:

            word = "bottle"

        print(new_num, word, "of beer on the wall.")

    print()
```

Assign the value "bottles" (a string) to a new variable called "word".

Loop a specified number of times, from 99 down to none. Use "beer_num" as the loop iteration variable.

The four calls to the print function display the current iteration's song lyrics, "99 bottles of beer on the wall. 99 bottles of beer. Take one down. Pass it around.", and so on with each iteration.

Check to see if we are on the last passed-around beer...

And if we are, end the song lyrics.

Otherwise...

Remember the number of the next beer in another variable called "new_num".

If we're about to drink our last beer...

Change the value of the "word" variable so the last lines of the lyric make sense.

Complete this iteration's song lyrics.

At the end of this iteration, print a blank line. When all the iterations are complete, terminate the program.

Don't Forget to Try the Beer Song Code

If you haven't done so already, type the beer song code into IDLE, save it as `beersong.py`, and then press F5 to take it for a spin. *Do not move on to the next chapter until you have a working beer song.*

THERE ARE NO DUMB QUESTIONS

Q: **Q: I keep getting errors when I try to run my beer song code. But my code looks fine to me, so I'm a little frustrated. Any suggestions?**

A: **A:** *The first thing to check is that you have your indentation right. If you do, then check to see if you have mixed tabs with spaces in your code. Remember: the code will look fine (to you), but the interpreter refuses to run it. If you suspect this, a quick fix is to bring your code into an IDLE edit window, then choose Edit... →Select All from the menu system, before choosing Format... →Untabify Region. If you've mixed tabs with spaces, this will convert all your tabs to spaces in one go (and fix any indentation issues). You can then save your code and press F5 to try running it again. If it still refuses to run, check that your code is exactly the same as we presented in this chapter. Be very careful of any spelling mistakes you may have made with your variable names.*

Q: **Q: The Python interpreter won't warn me if I misspell** `new_num` **as**`nwe_num`**?**

A: **A:** *No, it won't. As long as a variable is assigned a value, Python assumes you know what you're doing, and continues to execute your code. It is something to watch for, though, so be vigilant.*

WRAPPING UP WHAT YOU ALREADY KNOW

Here are some new things you learned as a result of working through (and running) the beer song code:

BULLET POINTS

- Indentation takes a little time to get used to. Every programmer new to Python complains about indentation at some point, but don't worry: soon you'll not even notice you're doing it.
- If there's one thing that you should never, ever do, it's mix tabs with spaces when indenting your Python code. Save yourself some future heartache, and don't do this.

- The `range` function can take more than one argument when invoked. These arguments let you control the start and stop values of the generated range, as well as the step value.
- The `range` function's step value can also be specified with a negative value, which changes the direction of the generated range

WITH ALL THE BEER GONE, WHAT'S NEXT?

That's it for Chapter 1. In the next chapter, you are going to learn a bit more about how Python handles data. We only just touched on **lists** in this chapter, and it's time to dive in a little deeper.

Chapter 1's Code

```
from datetime import datetime

odds = [ 1,  3,  5,  7,  9, 11, 13, 15, 17, 19,
        21, 23, 25, 27, 29, 31, 33, 35, 37, 39,
        41, 43, 45, 47, 49, 51, 53, 55, 57, 59 ]

right_this_minute = datetime.today().minute

if right_this_minute in odds:
    print("This minute seems a little odd.")
else:
    print("Not an odd minute.")
```

We started with the "odd.py" program, then...

... extended the code to create "odd2.py", which ran the "minute checking code" five times (thanks to the use of Python's "for" loop).

```
from datetime import datetime

import random
import time

odds = [ 1,  3,  5,  7,  9, 11, 13, 15, 17, 19,
        21, 23, 25, 27, 29, 31, 33, 35, 37, 39,
        41, 43, 45, 47, 49, 51, 53, 55, 57, 59 ]

for i in range(5):
    right_this_minute = datetime.today().minute
    if right_this_minute in odds:
        print("This minute seems a little odd.")
    else:
        print("Not an odd minute.")
    wait_time = random.randint(1, 60)
    time.sleep(wait_time)
```

```
word = "bottles"
for beer_num in range(99, 0, -1):
    print(beer_num, word, "of beer on the wall.")
    print(beer_num, word, "of beer.")
    print("Take one down.")
    print("Pass it around.")
    if beer_num == 1:
        print("No more bottles of beer on the wall.")
    else:
        new_num = beer_num - 1
        if new_num == 1:
            word = "bottle"
        print(new_num, word, "of beer on the wall.")
    print()
```

We concluded this chapter with the Python version of the Head First classic "beer song." And, yes, we know: it's hard not to work on this code without singing along... ☺