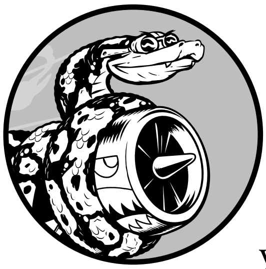
2

VARIABLES AND SIMPLE DATA TYPES



In this chapter you'll learn about the different kinds of data you can work with in your Python programs. You'll also learn how to store your data in variables and how to use those variables in your programs.

What Really Happens When You Run hello_world.py

Let's take a closer look at what Python does when you run *hello_world.py*. As it turns out, Python does a fair amount of work, even when it runs a simple program:

hello_world.py

```
print("Hello Python world!")
```

When you run this code, you should see this output:

```
Hello Python world!
```

When you run the file *hello_world.py*, the ending *.py* indicates that the file is a Python program. Your editor then runs the file through the *Python interpreter,* which reads through the program and determines what each word in the program means. For example, when the interpreter sees the word `print`, it prints to the screen whatever is inside the parentheses.

As you write your programs, your editor highlights different parts of your program in different ways. For example, it recognizes that `print` is the name of a function and displays that word in blue. It recognizes that "Hello Python world!" is not Python code and displays that phrase in orange. This feature is called *syntax highlighting* and is quite useful as you start to write your own programs.

Variables

Let's try using a variable in *hello_world.py*. Add a new line at the beginning of the file, and modify the second line:

```
message = "Hello Python world!"
print(message)
```

Run this program to see what happens. You should see the same output you saw previously:

```
Hello Python world!
```

We've added a *variable* named `message`. Every variable holds a *value,* which is the information associated with that variable. In this case the value is the text "Hello Python world!"

Adding a variable makes a little more work for the Python interpreter. When it processes the first line, it associates the text "Hello Python world!" with the variable `message`. When it reaches the second line, it prints the value associated with `message` to the screen.

Let's expand on this program by modifying *hello_world.py* to print a second message. Add a blank line to *hello_world.py*, and then add two new lines of code:

```
message = "Hello Python world!"
print(message)

message = "Hello Python Crash Course world!"
print(message)
```

Now when you run *hello_world.py*, you should see two lines of output:

```
Hello Python world!
Hello Python Crash Course world!
```

You can change the value of a variable in your program at any time, and Python will always keep track of its current value.

Naming and Using Variables

When you're using variables in Python, you need to adhere to a few rules and guidelines. Breaking some of these rules will cause errors; other guidelines just help you write code that's easier to read and understand. Be sure to keep the following variable rules in mind:

- Variable names can contain only letters, numbers, and underscores. They can start with a letter or an underscore, but not with a number. For instance, you can call a variable *message_1* but not *1_message*.
- Spaces are not allowed in variable names, but underscores can be used to separate words in variable names. For example, *greeting_message* works, but *greeting message* will cause errors.
- Avoid using Python keywords and function names as variable names; that is, do not use words that Python has reserved for a particular programmatic purpose, such as the word `print`. (See "Python Keywords and Built-in Functions" on page 489.)
- Variable names should be short but descriptive. For example, *name* is better than *n*, *student_name* is better than *s_n*, and *name_length* is better than *length_of_persons_name*.
- Be careful when using the lowercase letter *l* and the uppercase letter *O* because they could be confused with the numbers *1* and *0*.

It can take some practice to learn how to create good variable names, especially as your programs become more interesting and complicated. As you write more programs and start to read through other people's code, you'll get better at coming up with meaningful names.

NOTE *The Python variables you're using at this point should be lowercase. You won't get errors if you use uppercase letters, but it's a good idea to avoid using them for now.*

Avoiding Name Errors When Using Variables

Every programmer makes mistakes, and most make mistakes every day. Although good programmers might create errors, they also know how to respond to those errors efficiently. Let's look at an error you're likely to make early on and learn how to fix it.

We'll write some code that generates an error on purpose. Enter the following code, including the misspelled word *mesage* shown in bold:

```
message = "Hello Python Crash Course reader!"
print(mesage)
```

When an error occurs in your program, the Python interpreter does its best to help you figure out where the problem is. The interpreter provides a traceback when a program cannot run successfully. A *traceback* is a record of where the interpreter ran into trouble when trying to execute your code. Here's an example of the traceback that Python provides after you've accidentally misspelled a variable's name:

```
  Traceback (most recent call last):
❶   File "hello_world.py", line 2, in <module>
❷     print(mesage)
❸ NameError: name 'mesage' is not defined
```

The output at ❶ reports that an error occurs in line 2 of the file *hello_world.py*. The interpreter shows this line to help us spot the error quickly ❷ and tells us what kind of error it found ❸. In this case it found a *name error* and reports that the variable being printed, `mesage`, has not been defined. Python can't identify the variable name provided. A name error usually means we either forgot to set a variable's value before using it, or we made a spelling mistake when entering the variable's name.

Of course, in this example we omitted the letter *s* in the variable name `message` in the second line. The Python interpreter doesn't spellcheck your code, but it does ensure that variable names are spelled consistently. For example, watch what happens when we spell *message* incorrectly in another place in the code as well:

```
mesage = "Hello Python Crash Course reader!"
print(mesage)
```

In this case, the program runs successfully!

```
Hello Python Crash Course reader!
```

Computers are strict, but they disregard good and bad spelling. As a result, you don't need to consider English spelling and grammar rules when you're trying to create variable names and writing code.

Many programming errors are simple, single-character typos in one line of a program. If you're spending a long time searching for one of these errors, know that you're in good company. Many experienced and talented programmers spend hours hunting down these kinds of tiny errors. Try to laugh about it and move on, knowing it will happen frequently throughout your programming life.

NOTE *The best way to understand new programming concepts is to try using them in your programs. If you get stuck while working on an exercise in this book, try doing something else for a while. If you're still stuck, review the relevant part of that chapter. If you still need help, see the suggestions in Appendix C.*

TRY IT YOURSELF

Write a separate program to accomplish each of these exercises. Save each program with a filename that follows standard Python conventions, using lowercase letters and underscores, such as *simple_message.py* and *simple_messages.py*.

2-1. Simple Message: Store a message in a variable, and then print that message.

2-2. Simple Messages: Store a message in a variable, and print that message. Then change the value of your variable to a new message, and print the new message.

Strings

Because most programs define and gather some sort of data, and then do something useful with it, it helps to classify different types of data. The first data type we'll look at is the string. Strings are quite simple at first glance, but you can use them in many different ways.

A *string* is simply a series of characters. Anything inside quotes is considered a string in Python, and you can use single or double quotes around your strings like this:

```
"This is a string."
'This is also a string.'
```

This flexibility allows you to use quotes and apostrophes within your strings:

```
'I told my friend, "Python is my favorite language!"'
"The language 'Python' is named after Monty Python, not the snake."
"One of Python's strengths is its diverse and supportive community."
```

Let's explore some of the ways you can use strings.

Changing Case in a String with Methods

One of the simplest tasks you can do with strings is change the case of the words in a string. Look at the following code, and try to determine what's happening:

name.py

```
name = "ada lovelace"
print(name.title())
```

Save this file as *name.py*, and then run it. You should see this output:

```
Ada Lovelace
```

In this example, the lowercase string `"ada lovelace"` is stored in the variable `name`. The method `title()` appears after the variable in the `print()` statement. A *method* is an action that Python can perform on a piece of data. The dot (`.`) after `name` in `name.title()` tells Python to make the `title()` method act on the variable `name`. Every method is followed by a set of parentheses, because methods often need additional information to do their work. That information is provided inside the parentheses. The `title()` function doesn't need any additional information, so its parentheses are empty.

`title()` displays each word in titlecase, where each word begins with a capital letter. This is useful because you'll often want to think of a name as a piece of information. For example, you might want your program to recognize the input values `Ada`, `ADA`, and `ada` as the same name, and display all of them as `Ada`.

Several other useful methods are available for dealing with case as well. For example, you can change a string to all uppercase or all lowercase letters like this:

```
name = "Ada Lovelace"
print(name.upper())
print(name.lower())
```

This will display the following:

```
ADA LOVELACE
ada lovelace
```

The `lower()` method is particularly useful for storing data. Many times you won't want to trust the capitalization that your users provide, so you'll convert strings to lowercase before storing them. Then when you want to display the information, you'll use the case that makes the most sense for each string.

Combining or Concatenating Strings

It's often useful to combine strings. For example, you might want to store a first name and a last name in separate variables, and then combine them when you want to display someone's full name:

```
  first_name = "ada"
  last_name = "lovelace"
❶ full_name = first_name + " " + last_name

  print(full_name)
```

Python uses the plus symbol (+) to combine strings. In this example, we use + to create a full name by combining a `first_name`, a space, and a `last_name` ❶, giving this result:

```
ada lovelace
```

This method of combining strings is called *concatenation*. You can use concatenation to compose complete messages using the information you've stored in a variable. Let's look at an example:

```
  first_name = "ada"
  last_name = "lovelace"
  full_name = first_name + " " + last_name

❶ print("Hello, " + full_name.title() + "!")
```

Here, the full name is used at ❶ in a sentence that greets the user, and the `title()` method is used to format the name appropriately. This code returns a simple but nicely formatted greeting:

```
Hello, Ada Lovelace!
```

You can use concatenation to compose a message and then store the entire message in a variable:

```
  first_name = "ada"
  last_name = "lovelace"
  full_name = first_name + " " + last_name

❶ message = "Hello, " + full_name.title() + "!"
❷ print(message)
```

This code displays the message "Hello, Ada Lovelace!" as well, but storing the message in a variable at ❶ makes the final `print` statement at ❷ much simpler.

Adding Whitespace to Strings with Tabs or Newlines

In programming, *whitespace* refers to any nonprinting character, such as spaces, tabs, and end-of-line symbols. You can use whitespace to organize your output so it's easier for users to read.

To add a tab to your text, use the character combination `\t` as shown at ❶:

```
>>> print("Python")
Python
❶ >>> print("\tPython")
    Python
```

To add a newline in a string, use the character combination `\n`:

```
>>> print("Languages:\nPython\nC\nJavaScript")
Languages:
Python
C
JavaScript
```

You can also combine tabs and newlines in a single string. The string `"\n\t"` tells Python to move to a new line, and start the next line with a tab. The following example shows how you can use a one-line string to generate four lines of output:

```
>>> print("Languages:\n\tPython\n\tC\n\tJavaScript")
Languages:
    Python
    C
    JavaScript
```

Newlines and tabs will be very useful in the next two chapters when you start to produce many lines of output from just a few lines of code.

Stripping Whitespace

Extra whitespace can be confusing in your programs. To programmers `'python'` and `'python '` look pretty much the same. But to a program, they are two different strings. Python detects the extra space in `'python '` and considers it significant unless you tell it otherwise.

It's important to think about whitespace, because often you'll want to compare two strings to determine whether they are the same. For example, one important instance might involve checking people's usernames when they log in to a website. Extra whitespace can be confusing in much simpler situations as well. Fortunately, Python makes it easy to eliminate extraneous whitespace from data that people enter.

Python can look for extra whitespace on the right and left sides of a string. To ensure that no whitespace exists at the right end of a string, use the `rstrip()` method.

```
❶ >>> favorite_language = 'python '
❷ >>> favorite_language
  'python '
❸ >>> favorite_language.rstrip()
  'python'
❹ >>> favorite_language
  'python '
```

The value stored in favorite_language at ❶ contains extra whitespace at the end of the string. When you ask Python for this value in a terminal session, you can see the space at the end of the value ❷. When the rstrip() method acts on the variable favorite_language at ❸, this extra space is removed. However, it is only removed temporarily. If you ask for the value of favorite_language again, you can see that the string looks the same as when it was entered, including the extra whitespace ❹.

To remove the whitespace from the string permanently, you have to store the stripped value back into the variable:

```
  >>> favorite_language = 'python '
❶ >>> favorite_language = favorite_language.rstrip()
  >>> favorite_language
  'python'
```

To remove the whitespace from the string, you strip the whitespace from the right side of the string and then store that value back in the original variable, as shown at ❶. Changing a variable's value and then storing the new value back in the original variable is done often in programming. This is how a variable's value can change as a program is executed or in response to user input.

You can also strip whitespace from the left side of a string using the lstrip() method or strip whitespace from both sides at once using strip():

```
❶ >>> favorite_language = ' python '
❷ >>> favorite_language.rstrip()
  ' python'
❸ >>> favorite_language.lstrip()
  'python '
❹ >>> favorite_language.strip()
  'python'
```

In this example, we start with a value that has whitespace at the beginning and the end ❶. We then remove the extra space from the right side at ❷, from the left side at ❸, and from both sides at ❹. Experimenting with these stripping functions can help you become familiar with manipulating strings. In the real world, these stripping functions are used most often to clean up user input before it's stored in a program.

Avoiding Syntax Errors with Strings

One kind of error that you might see with some regularity is a syntax error. A *syntax error* occurs when Python doesn't recognize a section of your program as valid Python code. For example, if you use an apostrophe within single quotes, you'll produce an error. This happens because Python interprets everything between the first single quote and the apostrophe as a string. It then tries to interpret the rest of the text as Python code, which causes errors.

Here's how to use single and double quotes correctly. Save this program as *apostrophe.py* and then run it:

apostrophe.py

```
message = "One of Python's strengths is its diverse community."
print(message)
```

The apostrophe appears inside a set of double quotes, so the Python interpreter has no trouble reading the string correctly:

```
One of Python's strengths is its diverse community.
```

However, if you use single quotes, Python can't identify where the string should end:

```
message = 'One of Python's strengths is its diverse community.'
print(message)
```

You'll see the following output:

```
  File "apostrophe.py", line 1
    message = 'One of Python's strengths is its diverse community.'
                             ^❶
SyntaxError: invalid syntax
```

In the output you can see that the error occurs at ❶ right after the second single quote. This *syntax error* indicates that the interpreter doesn't recognize something in the code as valid Python code. Errors can come from a variety of sources, and I'll point out some common ones as they arise. You might see syntax errors often as you learn to write proper Python code. Syntax errors are also the least specific kind of error, so they can be difficult and frustrating to identify and correct. If you get stuck on a particularly stubborn error, see the suggestions in Appendix C.

NOTE *Your editor's syntax highlighting feature should help you spot some syntax errors quickly as you write your programs. If you see Python code highlighted as if it's English or English highlighted as if it's Python code, you probably have a mismatched quotation mark somewhere in your file.*

Printing in Python 2

The print statement has a slightly different syntax in Python 2:

```
>>> python2.7
>>> print "Hello Python 2.7 world!"
Hello Python 2.7 world!
```

Parentheses are not needed around the phrase you want to print in Python 2. Technically, print is a function in Python 3, which is why it needs parentheses. Some Python 2 print statements do include parentheses, but the behavior can be a little different than what you'll see in Python 3. Basically, when you're looking at code written in Python 2, expect to see some print statements with parentheses and some without.

TRY IT YOURSELF

Save each of the following exercises as a separate file with a name like *name_cases.py*. If you get stuck, take a break or see the suggestions in Appendix C.

2-3. Personal Message: Store a person's name in a variable, and print a message to that person. Your message should be simple, such as, "Hello Eric, would you like to learn some Python today?"

2-4. Name Cases: Store a person's name in a variable, and then print that person's name in lowercase, uppercase, and titlecase.

2-5. Famous Quote: Find a quote from a famous person you admire. Print the quote and the name of its author. Your output should look something like the following, including the quotation marks:

> *Albert Einstein once said, "A person who never made a mistake never tried anything new."*

2-6. Famous Quote 2: Repeat Exercise 2-5, but this time store the famous person's name in a variable called `famous_person`. Then compose your message and store it in a new variable called `message`. Print your message.

2-7. Stripping Names: Store a person's name, and include some whitespace characters at the beginning and end of the name. Make sure you use each character combination, `"\t"` and `"\n"`, at least once.

Print the name once, so the whitespace around the name is displayed. Then print the name using each of the three stripping functions, `lstrip()`, `rstrip()`, and `strip()`.

Numbers

Numbers are used quite often in programming to keep score in games, represent data in visualizations, store information in web applications, and so on. Python treats numbers in several different ways, depending on how they are being used. Let's first look at how Python manages integers, because they are the simplest to work with.

Integers

You can add (+), subtract (-), multiply (*), and divide (/) integers in Python.

```
>>> 2 + 3
5
>>> 3 - 2
1
>>> 2 * 3
6
>>> 3 / 2
1.5
```

In a terminal session, Python simply returns the result of the operation. Python uses two multiplication symbols to represent exponents:

```
>>> 3 ** 2
9
>>> 3 ** 3
27
>>> 10 ** 6
1000000
```

Python supports the order of operations too, so you can use multiple operations in one expression. You can also use parentheses to modify the order of operations so Python can evaluate your expression in the order you specify. For example:

```
>>> 2 + 3*4
14
>>> (2 + 3) * 4
20
```

The spacing in these examples has no effect on how Python evaluates the expressions; it simply helps you more quickly spot the operations that have priority when you're reading through the code.

Floats

Python calls any number with a decimal point a *float*. This term is used in most programming languages, and it refers to the fact that a decimal point can appear at any position in a number. Every programming language must be carefully designed to properly manage decimal numbers so numbers behave appropriately no matter where the decimal point appears.

For the most part, you can use decimals without worrying about how they behave. Simply enter the numbers you want to use, and Python will most likely do what you expect:

```
>>> 0.1 + 0.1
0.2
>>> 0.2 + 0.2
0.4
>>> 2 * 0.1
0.2
>>> 2 * 0.2
0.4
```

But be aware that you can sometimes get an arbitrary number of decimal places in your answer:

```
>>> 0.2 + 0.1
0.30000000000000004
>>> 3 * 0.1
0.30000000000000004
```

This happens in all languages and is of little concern. Python tries to find a way to represent the result as precisely as possible, which is sometimes difficult given how computers have to represent numbers internally. Just ignore the extra decimal places for now; you'll learn ways to deal with the extra places when you need to in the projects in Part II.

Avoiding Type Errors with the str() Function

Often, you'll want to use a variable's value within a message. For example, say you want to wish someone a happy birthday. You might write code like this:

birthday.py

```
age = 23
message = "Happy " + age + "rd Birthday!"

print(message)
```

You might expect this code to print the simple birthday greeting, `Happy 23rd birthday!` But if you run this code, you'll see that it generates an error:

```
  Traceback (most recent call last):
    File "birthday.py", line 2, in <module>
      message = "Happy " + age + "rd Birthday!"
❶ TypeError: Can't convert 'int' object to str implicitly
```

This is a *type error*. It means Python can't recognize the kind of information you're using. In this example Python sees at ❶ that you're using a variable that has an integer value (`int`), but it's not sure how to interpret that value. Python knows that the variable could represent either the numerical value 23 or the characters *2* and *3*. When you use integers within strings like this, you need to specify explicitly that you want Python to use the integer as a string of characters. You can do this by wrapping the variable in the `str()` function, which tells Python to represent non-string values as strings:

```
age = 23
message = "Happy " + str(age) + "rd Birthday!"

print(message)
```

Python now knows that you want to convert the numerical value 23 to a string and display the characters `2` and `3` as part of the birthday message. Now you get the message you were expecting, without any errors:

```
Happy 23rd Birthday!
```

Working with numbers in Python is straightforward most of the time. If you're getting unexpected results, check whether Python is interpreting your numbers the way you want it to, either as a numerical value or as a string value.

Integers in Python 2

Python 2 returns a slightly different result when you divide two integers:

```
>>> python2.7
>>> 3 / 2
1
```

Instead of `1.5`, Python returns `1`. Division of integers in Python 2 results in an integer with the remainder truncated. Note that the result is not a rounded integer; the remainder is simply omitted.

To avoid this behavior in Python 2, make sure that at least one of the numbers is a float. By doing so, the result will be a float as well:

```
>>> 3 / 2
1
>>> 3.0 / 2
1.5
>>> 3 / 2.0
1.5
>>> 3.0 / 2.0
1.5
```

This division behavior is a common source of confusion when people who are used to Python 3 start using Python 2, or vice versa. If you use or create code that mixes integers and floats, watch out for irregular behavior.

TRY IT YOURSELF

2-8. Number Eight: Write addition, subtraction, multiplication, and division operations that each result in the number 8. Be sure to enclose your operations in `print` statements to see the results. You should create four lines that look like this:

```
print(5 + 3)
```

Your output should simply be four lines with the number 8 appearing once on each line.

2-9. Favorite Number: Store your favorite number in a variable. Then, using that variable, create a message that reveals your favorite number. Print that message.

Comments

Comments are an extremely useful feature in most programming languages. Everything you've written in your programs so far is Python code. As your programs become longer and more complicated, you should add notes within your programs that describe your overall approach to the problem you're solving. A *comment* allows you to write notes in English within your programs.

How Do You Write Comments?

In Python, the hash mark (`#`) indicates a comment. Anything following a hash mark in your code is ignored by the Python interpreter. For example:

comment.py

```
# Say hello to everyone.
print("Hello Python people!")
```

Python ignores the first line and executes the second line.

```
Hello Python people!
```

What Kind of Comments Should You Write?

The main reason to write comments is to explain what your code is supposed to do and how you are making it work. When you're in the middle of working on a project, you understand how all of the pieces fit together. But when you return to a project after some time away, you'll likely have forgotten some of the details. You can always study your code for a while and figure out how segments were supposed to work, but writing good comments can save you time by summarizing your overall approach in clear English.

If you want to become a professional programmer or collaborate with other programmers, you should write meaningful comments. Today, most software is written collaboratively, whether by a group of employees at one company or a group of people working together on an open source project. Skilled programmers expect to see comments in code, so it's best to start adding descriptive comments to your programs now. Writing clear, concise comments in your code is one of the most beneficial habits you can form as a new programmer.

When you're determining whether to write a comment, ask yourself if you had to consider several approaches before coming up with a reasonable way to make something work; if so, write a comment about your solution. It's much easier to delete extra comments later on than it is to go back and write comments for a sparsely commented program. From now on, I'll use comments in examples throughout this book to help explain sections of code.

TRY IT YOURSELF

2-10. Adding Comments: Choose two of the programs you've written, and add at least one comment to each. If you don't have anything specific to write because your programs are too simple at this point, just add your name and the current date at the top of each program file. Then write one sentence describing what the program does.

The Zen of Python

For a long time, the programming language Perl was the mainstay of the Internet. Most interactive websites in the early days were powered by Perl scripts. The Perl community's motto at the time was, "There's more than one way to do it." People liked this mind-set for a while, because the flexibility written into the language made it possible to solve most problems in a variety of ways. This approach was acceptable while working on your own projects, but eventually people realized that the emphasis on flexibility made it difficult to maintain large projects over long periods of time. It was difficult, tedious, and time-consuming to review code and try to figure out what someone else was thinking when they were solving a complex problem.

Experienced Python programmers will encourage you to avoid complexity and aim for simplicity whenever possible. The Python community's philosophy is contained in "The Zen of Python" by Tim Peters. You can access this brief set of principles for writing good Python code by entering `import this` into your interpreter. I won't reproduce the entire "Zen of

Python" here, but I'll share a few lines to help you understand why they should be important to you as a beginning Python programmer.

```
>>> import this
The Zen of Python, by Tim Peters

Beautiful is better than ugly.
```

Python programmers embrace the notion that code can be beautiful and elegant. In programming, people solve problems. Programmers have always respected well-designed, efficient, and even beautiful solutions to problems. As you learn more about Python and use it to write more code, someone might look over your shoulder one day and say, "Wow, that's some beautiful code!"

```
Simple is better than complex.
```

If you have a choice between a simple and a complex solution, and both work, use the simple solution. Your code will be easier to maintain, and it will be easier for you and others to build on that code later on.

```
Complex is better than complicated.
```

Real life is messy, and sometimes a simple solution to a problem is unattainable. In that case, use the simplest solution that works.

```
Readability counts.
```

Even when your code is complex, aim to make it readable. When you're working on a project that involves complex coding, focus on writing informative comments for that code.

```
There should be one-- and preferably only one --obvious way to do it.
```

If two Python programmers are asked to solve the same problem, they should come up with fairly compatible solutions. This is not to say there's no room for creativity in programming. On the contrary! But much of programming consists of using small, common approaches to simple situations within a larger, more creative project. The nuts and bolts of your programs should make sense to other Python programmers.

```
Now is better than never.
```

You could spend the rest of your life learning all the intricacies of Python and of programming in general, but then you'd never complete any projects. Don't try to write perfect code; write code that works, and then decide whether to improve your code for that project or move on to something new.

As you continue to the next chapter and start digging into more involved topics, try to keep this philosophy of simplicity and clarity in mind. Experienced programmers will respect your code more and will be happy to give you feedback and collaborate with you on interesting projects.

TRY IT YOURSELF

2-11. Zen of Python: Enter `import this` into a Python terminal session and skim through the additional principles.

Summary

In this chapter you learned to work with variables. You learned to use descriptive variable names and how to resolve name errors and syntax errors when they arise. You learned what strings are and how to display strings using lowercase, uppercase, and titlecase. You started using whitespace to organize output neatly, and you learned to strip unneeded whitespace from different parts of a string. You started working with integers and floats, and you read about some unexpected behavior to watch out for when working with numerical data. You also learned to write explanatory comments to make your code easier for you and others to read. Finally, you read about the philosophy of keeping your code as simple as possible, whenever possible.

In Chapter 3 you'll learn to store collections of information in variables called *lists*. You'll learn to work through a list, manipulating any information in that list.