

Python

Debugging

Handbook

R
L

Z
i
m
m
e
r
m
a
n

Anaconda Spyder IDE

Python

Debugging

Handbook

R
L

Z
i
m
m
e
r
m
a
n

Anaconda Spyder IDE

Python Debugging

RL Zimmerman

Table of Contents

1. Introduction

1.1 Overview

1.2 What This Book is About

1.3 What's Next?

2. Debugging Overview

2.1 Plan for Debugging

Start Small

Keep Multiple Versions of Your Code

Intended Outcome

Test Data Files

Plan for Tomorrow

2.2 Debugging Steps

Logbook

Divide and Conquer

Backup Files Before Debugging

Problem Statement

Doubt Everything

Look Around Your Environment

Create a List of Suspects

[What Do You Think is the Cause?](#)
[Refine Your Experiment](#)
[Experiment](#)
[Success at Last](#)

[2.3 The Debugging Environment](#)

[Python](#)
[Anaconda](#)
[Spyder](#)
[Run a Script or Program](#)

[2.4 Help](#)

[2.5 What's Next?](#)

[3. Python Basics](#)

[3.1 Statements](#)

[3.2 Python Syntax](#)

[3.3 Objects](#)

[3.4 Immutable Objects](#)

[3.5 Variables](#)

[3.6 Types of Data](#)

[What is the Data Type?](#)
[Converting Data Types](#)
[The 'None' Value](#)

[3.7 Numbers](#)

[3.8 Strings](#)

3.9 Introduction to Data Structures

3.10 List

[Iterate Through Items in a List](#)

3.11 Tuple

[Iterate Through Items in a Tuple](#)

3.12 Dictionary

[Create a Dictionary](#)

[Assign a Dictionary Value Using the Key Name](#)

[Add a New Key to an Existing Dictionary](#)

[Iterate Through Key-Pairs in a Dictionary](#)

[Iterate Through Keys in a Dictionary](#)

[Access the Value of a Dictionary Item](#)

3.13 Set

3.14 Comparison Operators

3.15 Control Statements

3.16 Indented Code (a Suite)

3.17 Functions and Methods

[Defining a Function](#)

[Parameters](#)

[Arguments](#)

[KEYWORD ARGUMENTS](#)

[POSITIONAL ARGUMENTS](#)

[OPTIONAL ARGUMENTS](#)

[AN ARBITRARY NUMBER OF ARGUMENTS](#)

[HOW TO VIEW THE FUNCTION ARGUMENT DEFINITION](#)

[Calling a Function or Method](#)

[Function Return Value](#)

[All Paths Do Not Have a Return Value](#)

[More than One Return Value](#)

[The Type of Return Value](#)

[3.18 Classes](#)

[Create a Class](#)

[The DocString](#)

[Variables - Attributes](#)

[Instance Variables and Class Variables](#)

[Create an Instance of the Class](#)

[Methods](#)

[Dotted Notation for Attributes](#)

[Calling a Method](#)

[3.19 Attributes](#)

[4. Debugging Tools](#)

[4.1 Debugging Overview](#)

[4.2 Add Print Statements to Your Script](#)

[Indenting Loop Print Statements](#)

[4.3 Debug Mode](#)

[End Debug Mode](#)

[4.4 Variable Explorer](#)

[4.5 Example: My Program Loops and Never Ends](#)

[4.6 Debug Commands](#)

4.7 Interactive Mode

[Increment Counters in the Console](#)

[Watch Out for Changing Values](#)

[iPython Session](#)

4.8 Introspection

[Variables and Objects in Memory](#)

[Using ? in the Console](#)

[dir\(\)](#)

[help\(\)](#)

[The Inspect Library](#)

[The type\(\) Function](#)

[The id\(\) Function](#)

[The repr\(\) Function](#)

[The len\(\) Function](#)

4.9 Logging

4.10 The timeit() Function

4.11 Focused Testing

[Actual Result](#)

[Incorrect Code](#)

4.12 Create Test Data

5. Exceptions

5.1 Kinds of Errors

[Syntax](#)

[Logic or Semantic](#)

[Runtime](#)

5.2 The Stack Trace or Traceback

Don't Be Fooled

5.3 Try and Except

5.4 Raise

5.5 Assert

5.6 Built-in Error Types

ArithmeticError

AssertionError

AttributeError

EOFError

FloatingPointError

ImportError

Indentation Error

IndexError

IOError

KeyError

KeyboardInterrupt

LookupError

MemoryError

ModuleNotFoundError

NameError

OSError

OverflowError

RecursionError

RuntimeError

StopIteration

SyntaxError

TabError

SystemError

[SystemExit](#)
[TypeError](#)
[ValueError](#)
[ZeroDivisionError](#)

6. Try This

6.1 What is the Object Value?

6.2 String and Number Variable Values

[Print the Value of a String Variable](#)
[Inspect a Number Variable in Debug Mode](#)
[Inspect a String Value with Interactive Mode](#)

6.3 Tuple Objects and Values

[Print All Tuple Item Values](#)
[Print a Tuple Item Value](#)
[Inspect All Tuple Items in Interactive Mode](#)
[Inspect A Tuple Item in Interactive Mode](#)

6.4 List Objects and Values

[Print All List Item Values](#)
[Print the Value of a List Item](#)
[Inspect a List Item in Debug Mode](#)
[Inspect All Items of a List in the Console](#)
[Inspect a List Item in the Console](#)

6.5 Dictionary Objects and Values

[Print the Value of a Dictionary Key-Pair](#)
[Inspect All Dictionary Items in the Console](#)
[Inspect a Dictionary Item Value in the Console](#)
[Inspect a Dictionary Item in Variable Explorer](#)

6.6 Does the Object have a Value of None

or Whitespace?

[Whitespace](#)

6.7 What is the Object Type?

6.8 What is the Length of the Object?

6.9 What are the Function Arguments?

[The Function Call Signature](#)

6.10 What is the Return Object of the Function?

7. Examples

Ex 7.1 List Index Out of Range

[Intended Outcome](#)

[Actual Result](#)

[Incorrect Code](#)

[Debugging Experiment](#)

[How to Resolve the Issue](#)

[Good Code](#)

[Reference](#)

Ex 7.2 Index Error

[Intended Outcome](#)

[Actual Result](#)

[Incorrect Code](#)

[Debugging Steps](#)

[How to Resolve the Issue](#)

[Good Code](#)

[Reference](#)

Ex 7.3 Wrong Variable

[Intended Outcome](#)
[Actual Result](#)
[Incorrect Code](#)
[Debugging Steps](#)
[How to Resolve the Issue](#)
[Good Code](#)
[Reference](#)

Ex 7.4 Invalid Assignment

[Intended Outcome](#)
[Actual Result](#)
[Incorrect Code](#)
[Debugging Steps](#)
[How to Resolve the Issue](#)
[Good Code](#)
[Reference](#)

Ex 7.5 While Indentation Error

[Intended Outcome](#)
[Actual Result](#)
[Incorrect Code](#)
[Debugging Steps](#)
[How to Resolve the Issue](#)
[Good Code](#)
[Reference](#)

Ex 7.6 Incorrect Method Arguments

[Intended Outcome](#)
[Actual Result](#)
[Incorrect Code](#)
[Debugging Experiment](#)
[How to Resolve the Issue](#)
[Good Code](#)
[Reference](#)

Ex 7.7 Empty Block of Code

[Intended Outcome](#)

[Actual Result](#)

[Incorrect Code](#)

[Debugging Steps](#)

[How to Resolve the Issue](#)

[Good Code](#)

[Reference](#)

Ex 7.8 Parentheses Not Matched

[Intended Outcome](#)

[Actual Result](#)

[Incorrect Code](#)

[Debugging Steps](#)

[How to Resolve the Issue](#)

[Good Code](#)

[Reference](#)

Ex 7.9 Missing Colon

[Intended Outcome](#)

[Actual Result](#)

[Incorrect Code](#)

[Debugging Steps](#)

[How to Resolve the Issue](#)

[Good Code](#)

[Reference](#)

Ex 7.10 Case Sensitive

[Intended Outcome](#)

[Actual Result](#)

[Incorrect Code](#)

[Debugging Steps](#)

[How to Resolve the Issue](#)

[Good Code](#)
[Reference](#)

Ex 7.11 Missing Keyword

[Intended Outcome](#)
[Actual Result](#)
[Incorrect Code](#)
[Debugging Steps](#)
[How to Resolve the Issue](#)
[Good Code](#)
[Reference](#)

Ex 7.12 Illegal Character

[Intended Outcome](#)
[Actual Result](#)
[Incorrect Code](#)
[Debugging Steps](#)
[How to Resolve the Issue](#)
[Good Code](#)
[Reference](#)

Ex 7.13 Undefined Name

[Intended Outcome](#)
[Actual Result](#)
[Incorrect Code](#)
[Debugging Steps](#)
[How to Resolve the Issue](#)
[Good Code](#)
[Reference](#)

Ex 7.14 FileNotFound

[Intended Outcome](#)
[Actual Result](#)
[Incorrect Code](#)

[Debugging Steps](#)
[How to Resolve the Issue](#)
[Good Code](#)
[Reference](#)

Ex 7.15 Error Adding Numbers

[Intended Outcome](#)
[Actual Result](#)
[Incorrect Code](#)
[Debugging Steps](#)
[How to Resolve the Issue](#)
[Good Code](#)
[Reference](#)

Ex 7.16 Misspelled Keyword

[Intended Outcome](#)
[Actual Result](#)
[Incorrect Code](#)
[Debugging Steps](#)
[How to Resolve the Issue](#)
[Good Code](#)
[Reference](#)

Ex 7.17 Value is None

[Intended Outcome](#)
[Actual Result](#)
[Incorrect Code](#)
[Debugging Steps](#)
[How to Resolve the Issue](#)
[Good Code](#)
[Reference](#)

Ex 7.18 Method Not Found

[Intended Outcome](#)

[Actual Result](#)
[Incorrect Code](#)
[Debugging Steps](#)
[How to Resolve the Issue](#)
[Good Code](#)
[Reference](#)

Ex 7.19 Module Not Found

[Intended Outcome](#)
[Actual Result](#)
[Incorrect Code](#)
[Debugging Steps](#)
[How to Resolve the Issue](#)
[Good Code](#)
[Reference](#)

Ex 7.20 Key Not in Dictionary

[Intended Outcome](#)
[Actual Result](#)
[Incorrect Code](#)
[Debugging Experiment](#)
[How to Resolve the Issue](#)
[Good Code](#)
[Additional Troubleshooting](#)
[Reference](#)

Ex 7.21 Incorrect Argument Type

[Intended Outcome](#)
[Actual Result](#)
[Incorrect Code](#)
[Debugging Steps](#)
[How to Resolve the Issue](#)
[Good Code](#)
[Reference](#)

Ex 7.22 Name Error

[Intended Outcome](#)

[Actual Result](#)

[Incorrect Code](#)

[Debugging Steps](#)

[How to Resolve the Issue](#)

[Good Code](#)

[Reference](#)

Ex 7.23 Value Error

[Intended Outcome](#)

[Actual Result](#)

[Incorrect Code](#)

[Debugging Steps](#)

[How to Resolve the Issue](#)

[Good Code](#)

[Reference](#)

Ex 7.24 Divide by Zero Error

[Intended Outcome](#)

[Actual Result](#)

[Incorrect Code](#)

[Debugging Steps](#)

[How to Resolve the Issue](#)

[Good Code](#)

[Reference](#)

Ex 7.25 Math Logic Error

[Intended Outcome](#)

[Actual Result](#)

[Incorrect Code](#)

[Debugging Steps](#)

[How to Resolve the Issue](#)

[Good Code](#)

[**Ex 7.26 ValueError Assigning Date**](#)

[Intended Outcome](#)

[Actual Result](#)

[Incorrect Code](#)

[Debugging Steps](#)

[How to Resolve the Issue](#)

[Good Code](#)

[Reference](#)

[**Appendix - URLs**](#)

[**Arguments**](#)

[**Assert**](#)

[**Attributes**](#)

[**Built-in Functions**](#)

[**Calls**](#)

[**Classes**](#)

[**Comparisons**](#)

[**Containers**](#)

[**doctest**](#)

[**Functions**](#)

[**Glossary**](#)

[**The if Statement**](#)

Immutable

Inspect

Interactive Mode

Iterable and Iterations

Logging

Magic Functions

Methods

Objects

Parameters

The pass Statement

The return Statement

State

Statements

timeit

The try Statement

Types

Values

Conclusion

1. Introduction

Debugging is the process of finding and removing “bugs” or defects in a program. To help my daughter with her first Python class, I looked around for information on debugging that I could share with her. I wanted a simple guide with everything in one place and suggestions for how to go about the process of debugging. Initially, my research focused on gathering examples of common issues, but I knew something more was needed. After all, what happens if there is no example of the “bug” that you’re experiencing?

I knew I needed to provide a debugging “foundation.” Not just how to use debugging tools, but when to take action and why. With that goal in mind, Chapters 1 through 6 build a debugging arsenal, so you’re ready to tackle the examples in Chapter 7. Each example begins with “References” to the related topics covered in earlier chapters. So theoretically, you could jump right into the examples in Chapter 7.

This book includes an extensive and detailed Table of Contents. I also made a point to cross-reference topics so you can easily locate whatever you’re interested in from any point in the material. This approach means you can pick up the book at any time and quickly jump back in where you left off. Or if you prefer, you can hop around from topic to topic with as much detail as you want.

Hopefully, after reading this book, you won’t feel like this man who posted a plea for help on a chat board. His frustration shows through in his comment, “For the love of God, how is this done?” Instead, you’ll know exactly how it’s done and have fun doing it!

1.1 Overview

How you may ask, are we going to build your debugging arsenal? Let's begin with these topics.

- How to use the debug environment.
- The Python Error Codes and specific examples of how they happen.
- Step-by-step instructions on the process of debugging code.
- Finding the information you need to **modify your program** : help on Syntax, Functions, Classes, and more.

The goal of debugging is a working program, and debugging is just part of the process of writing code. When I realize I have a “bug,” I’ll experiment and try a few things to find a clue where the issue is. You’ll see this process in the examples in Chapter 7, where I use different approaches from my “debugging toolbox” to isolate an issue. You might take a different approach to the sample problem, and there is no wrong approach. The idea is to try a few things and see what works.

In this book, I demonstrate Python using the open-source Anaconda Data Science Distribution that includes Python version 3.7. Spyder, the Scientific Python Development Environment, comes with Anaconda. You may notice slight differences in screenshots, depending on whether I am using Spyder on my Windows or Mac computer.

1.2 What This Book is About

My intent in writing this book was not to provide a guide to Python Programming. Instead, this book is specifically about debugging Python with Anaconda’s Spyder application. The concepts around Python debugging apply equally to other environments, but the screens and debugging tools may vary slightly.

You may wonder why I’ve included Python Basics in Chapter 3. I found it difficult to explain an `IndexError` without first explaining data structures and their indexes. Similarly, a `Dictionary KeyError` doesn’t mean much without an understanding of a Dictionary. Syntax errors are fairly obvious in Spyder, but it doesn’t hurt to have a brief explanation of the syntax the parser expects.

Finally, Chapter 6 demonstrates how to view values, types, and the length of objects. Since the syntax varies by the type of object, I wanted to provide a reference with the exact syntax for each object type.

1.3 What's Next?

The next chapter walks you through installing Anaconda and the basic Spyder environment. We'll also look at an overall plan for debugging code.

2. Debugging Overview

In this Chapter we discuss

Plan for Debugging

Start Small

Keep Multiple Versions of Your Code

Intended Outcome

Test Data Files

Plan for Tomorrow

Experiment

Divide and Conquer

The Debugging Environment

Python

Anaconda & Spyder

Help

What's Next?

Writing code begins with your vision of what the program should do. You write code, see what happens, and make changes along the way. When the code doesn't do what you want, debugging helps you zero in on what's happening while the code runs. In essence, you can pause program execution and “freeze” your program at that point in time, looking at variable and object values at that moment.

This Chapter outlines a few suggestions to approach programming and debugging. The Examples in Chapter 7 follow a similar methodology.

Intended Outcome : What I wanted the program to do.

Actual Result : What the program did.

Incorrect Code : A look at the code before any changes.

Debugging Experiment : What I suspect is wrong with the program, and the steps I tried to “debug” what the program is doing.

How to Resolve the Issue : A brief description of the change to the code to achieve my “Intended Outcome.”

Correct Code : The finished code that works as I intended.



2.1 Plan for Debugging

Programming is not my primary job. Instead, programming is a tool I use for data mining or organizing projects. A day in my programming life includes lots of interruptions. It may be weeks or months before I pick up a project and continue coding. For this reason, I’ve adopted a few suggestions from programming friends to make my life easier.

1. Work on small chunks of code, test, and then move on to the next piece.
2. Keep multiple backup versions of your files.
3. Have a clear idea of what you want your program to do.
4. Use small data file samples that you know have clean data to develop your code. When you’ve tested your code and are confident there are no bugs, use live data connections or real data files.
5. Keep notes of where you stopped programming and the next steps.



Start Small

Write small chunks of code. Test and validate that piece of code, then move on. This “**Correct Code**” is also a good baseline for backups.

Keep Multiple Versions of Your Code

Keep multiple backup versions of your files. My backup files often include the date and time in the filename. That way, if I really mess up the code, I can easily go back to the “**Correct Code**” that worked earlier today or last month.

Intended Outcome

While I’m not suggesting you have a vision statement for your program, it doesn’t hurt to have an “**Intended Outcome**” of what you’re trying to accomplish. This synopsis is beneficial in several ways:

- Pair programming, or asking for another opinion.
- When you check-in your code to a source control program.
- During peer review.
- In a Sprint Review, where you demonstrate your program to others.

In case you reach out to another programmer for assistance, share as much information as possible.

1. The incorrect code. If you have the last working version of your code,

that might also be helpful.

2. Your **Debugging Experiment** methodology, and what you've already tried.
3. The "Actual Result." What happens when you run the program?

Test Data Files

Web scraping and external data files can be messy and huge. Take a moment to familiarize yourself with samples of the live data or data dumps. Make small "test data files" or mock-ups of the data. Scrub the data to ensure it's clean.

If you plan to code for blank data, hidden characters, or type conversions, set aside a version of the data for that purpose. Initially, keep the test data as simple as possible. Use these test data files to save time iterating through thousands (or millions) of rows of data.

Look for hidden characters and blank cells or data elements. Make notes of data types and other issues as a reminder to add logic to your code to handle the data correctly.

Often, when you dump database data to a CSV or Excel file, there is an error when you try to open the file. For example, if you open an Excel file, it may prompt you to "fix" the data on file open.

Chapter 4 has an example of a mock-up HTML data file in the topic "Create Test Data."

Plan for Tomorrow

When you're done for the day or decide to take a break, leave a note for yourself of where you stopped. Include what is or is not working and what you want to do next.

Review your pseudocode and **Intended Outcome** to be sure you're on the right track. Pseudocode is an outline of your program design in

simple terms, often written in plain English. These types of notes remind me of where I left off programming and what I need to work on next.

2.2 Debugging Steps

In some ways debugging is more of an art than science. Since I'm analytical, I am more inclined to use the scientific method for my debugging. It's really up to you to decide on your style of debugging, and if you'll use any of these suggestions.

1. When debugging, keep a **logbook** of your experiments, so you know what you've already tried.
2. Divide and conquer. Divide the code in half and test each half to see which part has the error. Repeat these steps to drill down to the location with the error.
3. Make a backup of your files before starting your experiments.
4. Start with a clear **Problem Statement** of the defect.
5. Don't believe everything you hear. If the original defect is the program works with Oracle data and not Cassandra data, verify that is really the case.
6. Examine the environment.
7. Create a list of possible suspects.
8. In case you're out of ideas and haven't found the defect, take a break. Work on something else, go for a walk or come back to the problem tomorrow.

Logbook

Keep a logbook of your debugging experiments. Write down the steps and outcome for each task. I find writing down my issues frees my mind from worrying about the problem, and allows me to brainstorm at my leisure.

Divide and Conquer

When debugging, pick a logical point to divide the code in half. Use a process of elimination to drill down to the error in the code.

1. Divide the program into **Part 1 Code** and **Part 2 Code** .
2. Run **Part 1 Code** . If there are no errors, you know that Part 1 is working. If you have errors, divide **Part 1 Code** again. Repeat the process until you drill down to the root cause.
3. If **Part 1 Code** ran without errors, run **Part 2 Code** . If you find an error divide **Part 2 Code** and repeat the steps.

Wherever possible, eliminate the code that is unrelated to the error. Chapter 4 has an example of skipping unrelated code in the topic “Focused Testing.”

Backup Files Before Debugging

Create a backup of your files before you change anything.

Problem Statement

Develop a clear problem statement with as much detail as possible. Who can you contact for more details? When determining how critical the issue is, consider the impact to business and if there is a workaround.

Doubt Everything

Verify the accuracy of the original defect report by recreating the issue yourself.

Look Around Your Environment

Before creating a list of possible causes, gather background on the

environment.

1. Has the program ever worked?
2. When was the last time the program ran successfully?
 - Did it work last month?
 - Is this the first time it ran on a Monday or on the first day of the month?
 - Is there heavy load on the environment because it's the end of the month or quarter?
3. Can you connect to devices outside of the program successfully?
Can you query the Cassandra database outside of your program? Is the web server responding to requests? Is one of the integrated systems down?
4. Did the program encounter an Out of Memory error?



Create a List of Suspects

As a starting point for your experiments, make a list of components that could be causing the defect.

- Your app
- The last few lines of code you changed
- Python language
- OS
- Connection to a web page
- The format of a database table or web page changed
- More than one library with the same name in different paths
- One of your script files with the same name as a library



What Do You Think is the Cause?

Chances are, at this point you have some idea where you want to start investigating. Make a list of your ideas or hypothesis of what might be wrong.

Refine Your Experiment

As you refine your **Debugging Experiment**, you'll probably notice parts of the code that you don't need to test. Your goal is to narrow the search by removing things that don't contribute to your hypothesis. Chapter 4 has an example that narrows your search in the topic "Focused Testing." Modify your program to temporarily eliminate these items from your experiment. Consider hard coding values or using temporary mock-ups of data.



Experiment

Change one thing at a time, and observe what happens. Please, write everything down in your logbook, noting each step and the outcome. The simple act of writing down my experiment forces me to pause and consider what happened and why.

- What steps did you take?

- What did you expect to happen?
- What actually happened?

Review the experiment and see if you can come up with a theory about the cause of the defect.

- Is there something you should not see?
- Do you need to refine your experiment further?
- Do you have a theory about what might be causing the defect?
- Do all your test results fit in with your theory, or is there one result that doesn't quite fit? Don't ignore the evidence that contradicts your theory. If you aren't sure how that piece of code works, dig into the code because that might be where the problem lies.

Keep a log of the things you've tried as you debug your program, to avoid repeating the same tests.



Success at Last

The last experiment you conduct that unequivocally works is the fix. The program does what you want, and you reach your “**Intended Outcome**.”

2.3 The Debugging Environment

For this book, I am using the Anaconda Distribution that includes the Spyder application. My Anaconda programs support Python 3.7.

Python

Python is an open-source (free) programming language for Web Development, GUI development, Scientific and Numeric data science, Software Development, and System Administration. The examples use the open-source Anaconda Data Science Distribution that includes Python version 3.7.

Spyder, the Scientific Python Development Environment, comes with Anaconda, and I run Python scripts in Spyder primarily on a Windows machine. For variety, I've also included several examples on a MAC computer.

In this Chapter, we'll install Anaconda and set up your environment. If you are familiar with Python and want to jump into debugging, feel free to skip ahead to Chapter 4.

Anaconda

Download the Anaconda Distribution that includes Python version 3.7. Other Python versions may vary slightly compared to the examples in this manual. When prompted, update your path settings. The install takes a while, so you might want to grab a cup of coffee or something.

Spyder

Spyder is an Integrated Desktop Environment or IDE. Spyder includes an Editor, Console or Spyder Shell, Variable Explorer, Help module, and other tools. These modules are displayed in "Panels" in Spyder.

On a Windows machine, launch Spyder from the Start Menu, in the Anaconda folder. On a MAC computer, open the Anaconda Navigator and launch "Spyder."

The Spyder Default Layout has three panes, as shown below. You can return to this layout at any time from the View menu under Windows Layouts. You can close or open other panes to suit your preferences.

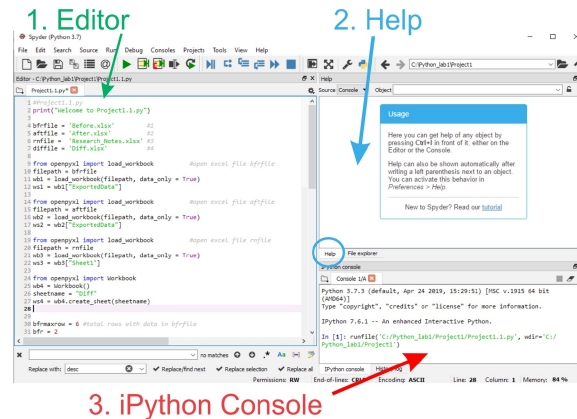


Figure 2.1 Project Files

1. The Editor window is where you type your code and create your script files.
2. The Help window displays syntax, function help, and more.
3. The iPython **Console** or Python shell. When you start Spyder the Console prompt is **In[1]:** .

When you click “Run,” ► the results are output to the Console. When you type a command in the Console, Python immediately runs the command. The Console is useful when debugging, or experimenting with different statements for your code.

Results displayed in the Console include code output and error messages. For example, if you use the `print()` method, the results are output to the Console window. In the example below, the **Console** displays “**Welcome to Project1.1.py** .”

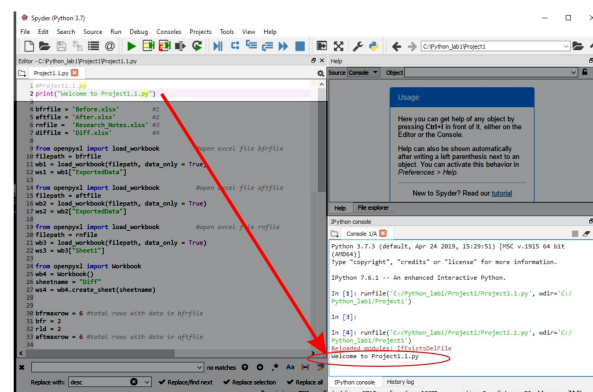


Figure 2.2 The iPython Console

Run a Script or Program

With Spyder open, click on the File menu and then click on “Open” and open, or create, a script file. In the next example, the “*Project1.1.py*” file is open in the Editor.

Click on the green arrow ► or use the **Run** menu, as shown below.

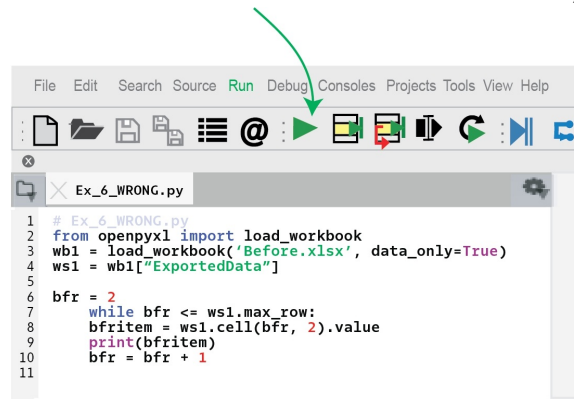


Figure 2.3 Run the Program

In the Run menu select ► “Run selection or current line” to run only the selected lines of code.

In the next figure, I have two panes open. The Editor is on the left, and the **Console** window is on the right. Initially, the **Console** window displays the prompt **In [1]:** . After I click “**Run** ,” the Console window changes, as shown below. The first output line displays the name of the program file and the working directory.

```
In [ 1 ]: runfile( 'C:/Python_lab1/Project1/Project1.1.py ', wdir=' C:/Python_lab1/Project1
')
```

Welcome to Project1.1.py

```
In [ 2 ]:
```

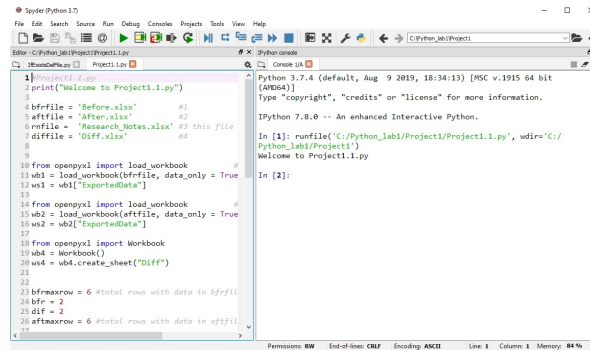


Figure 2.4 The Console

2.4 Help

In Spyder, click on the **View** menu and click “Panels” to open the “Help” pane. Now, click on the **Help** menu and click on “Spyder Tutorial.” The tutorial opens in the Help pane. The topic “Recommended first steps for Python beginners” is an excellent resource for new programmers.

Chapter 4 demonstrates [Debug Mode](#) , [Interactive Mode](#) , and Variable Explorer. These tools look at your code while it’s running, in effect, “debugging.”

To open Help for an object, place the cursor on an object name in the **Editor** , press Ctrl-I, or Command-I on a MAC. Help inspects the object and gathers [docstring](#) information.

2.5 What’s Next?

Your Lab environment is now setup. Let’s move on to Chapter 3 and review a few basic Python language guidelines.

3. Python Basics

In this chapter we discuss

Statements

Python Syntax

Objects

Immutable Objects

Variables

Types of Data

Numbers

Strings

Introduction to Data Structures

List

Tuple

Dictionary

Set

Comparison Operators

Control Statements

Indented Code (a Suite)

Functions & Methods

Classes

Now that your environment is set up, we'll take a brief look at a few basic Python concepts. Syntax and runtime errors often involve incorrect syntax, indentation errors, or a mismatch in object types. This chapter is by no means a complete Python language guide; instead, think of it as an abbreviated part of the Python language documentation. I need this small

subset of information to demonstrate how you will refer back to the Python documentation as you debug your program. The “Appendix - References” at the end of this book has links to the Python documentation related to these topics.

3.1 Statements

The actions that a program takes are called “statements.”

3.2 Python Syntax

The Spyder Integrated Development Environment (IDE) includes an Editor that warns you when you have a syntax error in your script. A yellow triangle on the left side of the Editor pane next to the line number indicates an error. Next, we’ll look at a few common causes of syntax errors.

- Valid characters for variable names and identifiers vary between Python 2.x and Python 3.x. Python 3 added support for Unicode characters in PEP 3131 to accomodate programmers who are not familiar with the English language. To avoid errors, I adhere to these guidelines.
 - Identifiers begin with a letter.
 - Numbers are allowed in object names, except as the first character. Object names are also known as identifiers.
 - In Python 2.x, the only special character allowed in an identifier name is an underscore. Instead of spaces in identifier names, try an underscore. Illegal spaces can cause a syntax error.
- The [PEP 8 Style Guide](#) suggests lowercase characters for identifier names and functions. Classes begin with an uppercase letter. For example, variables and list names are lowercase.
- Python is case sensitive. There is a difference between “myString” and “mystring.” The Python Interpreter displays a NameError when

there is a misspelled identifier.

- When defining a function or control statement, the line should always end with a colon.
- A data structure name should be plural, and items in the data set should be singular. For example, a **List** named “vacations” with List items: vacation[0], vacation[1], etc.
- Do not use reserved keywords as identifiers. A missing keyword causes a `SyntaxError`.
- Unpaired parentheses cause a `SyntaxError`.
- An empty Suite (indented block of code) is illegal. See “Indented Code (Suite)” or Example 7 for more information.

Python has reserved **keywords** like “global” or “try.” When you use a keyword as a variable name, it causes a syntax error.

These Chapter 7 examples illustrate a few syntax errors:

Example 7

Example 8

Example 9

Example 10

Example 11

Example 12

Example 16

3.3 Objects

An object is a collection of data. Everything in Python is an object. Objects have an identity, type, and value. The “identifier” or “identity” of the object is the name of the object. With the library “**openpyxl**,” you assign **objects** to both the workbook and worksheet, and then you use those **objects** with **methods** to read or update values (the data).

```
from openpyxl import load_workbook
```

```
wb2 = load_workbook(aftfile, data_only = True)
ws2 = wb2["ExportedData"]
```

3.4 Immutable Objects

Python string and number types are immutable, which means the values can not be changed. You can **not** change an existing string/int/float, but you can create a new string with changed data.

If you're new to programming, this concept may seem strange. Take the case of a Python object of the type "**int** ." The code statement **bfr = bfr + 1** seems to change the value of **bfr** . In reality, this statement creates a new object. The new object has a new identifier and a different location in memory. To see this in action, run this code in the **Console** to see the identifiers for the **bfr** objects.

```
print( id (bfr))
bfr = bfr + 1
print( id (bfr))
```

Immutable objects are quicker to access, and this improves code performance. Another advantage of immutable objects is understandability, and knowing the object will never change.

3.5 Variables

Think of a variable as a container to store values. When a program runs, the value inside the **variable** may change. A letter or number is a value. An **assignment statement** creates a variable and assigns a value, as shown below. The left side of an assignment statement must be a variable.

```
mynumber = 2000000
```

The Python style guide suggests that variable names begin with a letter.

3.6 Types of Data

Python has several types of data. Text, numeric, and sequence (list/tuple) are some of the built-in data types. The following table has a few of the basic data types. Data structures include lists, tuples, sets, and dictionaries.

Type	Description	Assignment	Value
int	integer	my_var=3	3
str	string of characters	my_var2='Hi'	Hi
float	floating-point number	my_var3=3.85	3.85
bool	boolean (true/false)	my_var4=false	false

Table 3.1 Data Types

When `my_var = 3`, the statement `float(my_var+5)` returns **8.0** .

When `my_var = 3`, the statement `print(34//my_var)` returns **11** .

What is the Data Type?

If you're unsure of the data type, the `type()` function displays the type of data.

```
print(type(my_var))
```

Converting Data Types

When working with data, you may need to change or convert the data type. For example, during a calculation, you may want to convert between a `float` and an `int` to remove decimal places. When concatenating numeric values and strings, you would convert the integer value to a string with the statement `str(my_int)`.

```
int(my_var)
```

```
str(my_var)
```

```
float(my_var)
```

```
bool(my_var)
```

The 'None' Value

In Python the absence of a value is called "None" which must be capitalized. In other languages this would be a null value. When a function has no return statement, it returns a value of "None." When working with external data sources you may have to account for this type of value, as shown in Example 17. An "if statement" that tests for a value of "None" is shown below.

```
if myvar is not None:
```

3.7 Numbers

When assigning integer values, do not use commas. Python interprets 2,000,000 as three integers separated by commas.

```
mynumber = 2000000
```

In the previous example, I assign 2000000 to the integer variable “**mynumber** .” For readability, you can add underscores as a separator.

```
mynumber = 2_000_000
```

3.8 Strings

A **string** is a sequence of characters. To assign a value to a string variable, use single quotes, as shown below. Strings are immutable and can not be changed. To assign a value to a string, use the same syntax and, in effect, create a new string variable with the same name.

```
mystring = 'books'
```

3.9 Introduction to Data Structures

There are four built-in data structures in Python. In this book, we'll primarily look at Lists, Tuples, and Dictionaries.

- List
- Tuple
- Dictionary
- Set

3.10 List

A **list** is an ordered collection of values of objects. Lists are usually of the same type, but can be a combination of types. A List is similar to an array in other languages. List values are mutable; the values can change. The list can grow or shrink as needed. A unique index (a number or name) refers to each list item. When creating Lists use square brackets **[]**. The index is used when updating list items.

```
ws1 = wb1["ExportedData"]
```

Python starts counting at **0**. The first item in a List has an index of **0**, and the second item has an index of **1**.

When creating a List, use brackets **[]**. A List can have heterogeneous data; meaning Lists can have different data types. Commas separate items.

Description	Syntax	Comments
Create a List and assign values	<code>mylist = ['a', 'b', 'c']</code>	
Create a List and assign number values	<code>mylist2=[1,2,3 4]</code>	
Assign a value to the first item in the List	<code>mylist2[0] = 8</code>	
Access the value of the List item	<code>mylist2[1]</code>	Returns the value of the first item in the List
Access the value of the last List item	<code>mylist2[-1]</code>	Use negative index numbers when counting from the right
Return all items in a List	<code>mylist</code>	

Table 2.1 List Objects

Iterate Through Items in a List

A “for loop” is one option to iterate through items in a List, as shown below.

```
for j in mylist:
```

```
    print('mylist item is:', mylist[j])
```

These Chapter 7 examples illustrate a few List errors:

Example 1

Example 2

Example 3

3.11 Tuple

A **tuple** is similar to a list and is immutable. Immutable objects can not be changed. Tuples use parentheses () and can have heterogeneous data, meaning Tuples can have different data types. Items are separated by commas. Only immutable elements are Dictionary keys, so only Tuples can be used as Dictionary keys. Lists are mutable and can not be used as Dictionary keys.

Tuple indices must be integers or slices, not a string.

Description	Syntax	Comments
Create a Tuple and assign values to 4 items	<code>mytuple = ('a', 'b', 'c', 'd')</code>	
Create an empty Tuple	<code>mytuple = tuple()</code>	
Create Tuple with one item	<code>mytuple2 = ('Rachel',)</code>	Notice the comma at the end to instruct Python this is a Tuple and not a String.
Assign number values to several Tuple items	<code>mytuple3 = (1, 2, 3)</code>	
Assign a value to the first item in mytuple4	<code>mytuple4[0]='Apple'</code>	The first item in the Tuple has an index value of 0.
View the value of the 2nd Tuple item	<code>In {1}: mytuple4[1] Orange</code>	The Python Interpreter returns the value Orange .

Table 2.2 Tuple Objects

Iterate Through Items in a Tuple

A “while loop” is one option to iterate through items in a Tuple, as shown below.

```
mytuple4 = ('Apple','Orange', 'Watermelon')
j = 0
while j < 3 :
    print('my fruit is:', mytuple4[j])
    j+= 1
```

A “for loop” is another option to iterate through items in a Tuple. Indices must be valid integers. The two samples below are valid and do the same thing.

```
mytuple4 = ( 0 , 1 , 2 )
for k in mytuple4:
    print('my number is:', k)
```

```
mytuple4 = ( 0 , 1 , 2 )
for k in mytuple4:
    print('my number is:', mytuple4[k])
```

The sample code below is invalid and causes an “**IndexError** ,” because there are only three objects in the Tuple with values 1, 2, 3. Python starts counting at 0. The print statement is using “**mytuple4[k]**” or `mytuple[1]`, `mytuple[2]`, and `mytuple[3]`. When you run the program, the

Python Interpreter warns that “**3**” is not a valid index.

```
mytuple4 = ( 1 , 2, 3 )  
for k in mytuple4:  
    print('my number is:', mytuple4[k])
```

3.12 Dictionary

A Dictionary is an ordered set of key/value pairs. Dictionaries are often depicted as two columns, with the list of keys in the first column, and values in the second column. Only immutable elements can be used as Dictionary keys, so while Tuples can be used as Dictionary keys, Lists are mutable and can not be used as Dictionary keys.

Key	Value
Name	John
Age	32
Height	5.10"

Table 2.3 Sample Dictionary

A Dictionary is unordered and can grow and shrink as needed. When creating Dictionaries, use curly braces `{}`. The key is followed by a colon `:` and a paired value. In the example below, the first key is 'Name,' and the value is '**Zimmerman** .' The second key is 'Grade,' and the value is '**A** .' A comma `,` separates the key pairs.

Create a Dictionary

To create a Dictionary with three key pairs, use the following syntax. For readability, the key pairs are usually written in this format.

```
mydictionary= { 'Name' : 'Zimmerman' ,
                'Grade' : 'A' ,
                'Course' : 'Python Programming' }
```

To create an empty dictionary type

```
mydictionary = { }
```

Assign a Dictionary Value Using the Key Name

To update a Dictionary value use the following syntax.

```
mydictionary['Name']: 'Smith'
```

Add a New Key to an Existing Dictionary

To add a new key, 'Credits' to an existing Dictionary, use this syntax.

```
mydictionary['Credits'] = '3'
```

Iterate Through Key-Pairs in a Dictionary

This “for loop” returns the key-pairs in the Dictionary. The first line in this example creates two variables “mykey” and “myvalue” for the key-value pairs. The method **items()** returns a list of the key-value pairs.

```
for mykey, myvalue in mydictionary.items():  
    print("\pKey: ", mykey, "\tValue: ", myvalue )
```

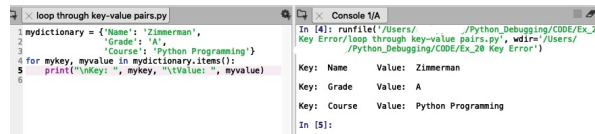


Figure 3.1 Print Key-Value Pairs

Iterate Through Keys in a Dictionary

This “for loop” returns the Keys in the Dictionary. To make your code easier to read, add the keys() method to the same statement.

```
for mykey in mydictionary:  
    print("\pKey: ", mykey )
```

The next example is the same statement with the keys() method.

```
for mykey in mydictionary.keys():  
    print("\pKey: ", mykey )
```

Access the Value of a Dictionary Item

This example uses the Console to display the value of the key “Name.” The Python Interpreter returns the value “Zimmerman” to the Console pane.

```
In [ 1 ] : mydictionary['Name']  
Zimmerman
```

In this next example, I modified the previous code that returned the

keys in the Dictionary. Here I use the **title()** method to access the Dictionary values.

```
for mykey in mydictionary.keys():  
    print(mykey, ":", mydictionary[mykey].title())
```

Another way to access Dictionary values is with the **values()** method, as shown below.

```
for myvalues in mydictionary.values():  
    print(myvalues.title())
```

3.13 Set

A Set is unordered objects and contains no duplicates. A Set grows or shrinks as needed. When working with Sets, there are functions to perform Unions, Intersections, and find Differences. When creating a set, use curly braces **{}** and separate items with a comma. The second row in the table below creates a set with one item. Notice the line ends in a comma, to indicate to Python this is a Set and not a String.

Description	Syntax	Comments
Create a Set and assign values	myset = {'a', 'b', 'c'}	
Create a Set with one item	myset2 = {'John',}	
Create an empty Set	myset3 = set()	
Create a Set and assign values	myset3 = set('abc')	With set() function

Table 2.4 Creating Sets

3.14 Comparison Operators

Use Comparison Operators to compare two values or for membership test operations.

Operator	Description	Type
>	Greater than	Values
<	Less than	Values
>=	Greater than or equal to	Values
<=	Less than or equal to	Values
==	Equal (values)	Values
!=	Not equal	Values
is	Equal (boolean)	Boolean
is not	Not Equal (boolean)	Boolean
in	Test for membership	
not in	Test for membership	

Table 2.5 Comparison Operators

3.15 Control Statements

Python control statements control the flow of the program. Examples of control statements are For, While, If, and Else. When the control statement is true, the indented lines that follow run.

The control statement always ends with a colon, and you indent the next line of code to the right. If you want to run several lines of code as part of the control statement, the lines are all indented to the same level.

The first line of the control statement, and all the indented lines that follow, is called a “Suite” in Python. Other programming languages often refer to this structure as a block of code.

A control statement moves through items in a data structure. When this program runs, each time the program loops through the code, the next item in the list is displayed.

```
fruits = ['Apple', 'Orange', 'Watermelon']  
for fruit in fruits:  
    print('my fruit is:', fruit)
```

An iteration variable can also be used to iterate list items. For example, when the variable “i” is a number with a value of “0.” The first time the loop runs list[i] refers to list[0]. The next time the list runs, list[i] refers to list[1].

```
fruits = ['Apple', 'Orange', 'Watermelon']  
for i in range( 3 ):  
    print('my fruit is:', fruits[i])
```

In Chapter 7, Example 20 demonstrates a “for” control statement.
Example 6 demonstrates a “while” control statement.

3.16 Indented Code (a Suite)

In the next figure, there is a red box around the code from line 28 to 48. I added a red vertical dotted line to highlight where the code is indented. This is a Suite of code.

Let’s look at the code on lines 29, 30, 31, 32, and 48. These lines are all indented to the same vertical level. This code Suite, or block of code, begins on line 28. The last line in this code Suite is line 48.

Indentation in Python scripts defines a “Suite” or code block.

In this example, the shaded Suite (block of code) is a second “while loop” (lines 34 to 46.) This second Suite is “nested” because it is inside the first Suite. Within the nested Suite, line 38 only runs when the **if statement** on line 37 evaluates to “**true** .” A nested if statement means there is a second “if statement” within the first if statement.

In this example, the “**bfr** ” counter on line 48 is the last line in this Suite and, in effect, moves forward in the loop to the next item.

```

22
23 bfrmaxrow = 6 #total rows with data in bfrfile
24 bfr = 2
25 dif = 2
26 aftmaxrow = 6 #total rows with data in aftfile
27
28 while bfr <= bfrmaxrow:
29     bfritem = ws1.cell(row = bfr, column = 2)
30     aft = 2
31     itemretired = 1
32     while aft <= aftmaxrow:
33         #if
34         aftitem = ws2.cell(row = aft, column = 2)
35         if bfritem.value == aftitem.value:
36             itemretired = 0
37             if ws1.cell(bfr, 3).value == ws2.cell(aft, 3).value: #cells match
38                 aft = aftmaxrow + 1
39             else:
40                 ws4.cell(row = dif, column = 1).value = bfritem.value
41                 ws4.cell(row = dif, column = 2).value = ws1.cell(row = bfr, column = 3).value
42                 ws4.cell(row = dif, column = 3).value = ws2.cell(row = aft, column = 3).value
43                 dif = dif + 1
44                 aft = aftmaxrow + 1
45             else:
46                 aft = aft + 1 #move to next row in aftfile
47                 #if
48                 bfr = bfr + 1 #move to next row in bfrfile
49

```

Figure 3.2 An Indented “Suite” or Block of Code

In Python, an empty Suite (indented block of code) is illegal. For example, an “if statement” that does nothing is illegal. Instead, use the “pass” function when your code should take no action, as shown in Chapter 7, Example 7. These Chapter 7 examples illustrate a few List errors:

Example 1

Example 2

3.17 Functions and Methods

Functions are a sequence of statements. When you define a function within a class, it is called a **method** . First, you define a function. Once a function is defined, you can use it as many times as you like by calling the function.

```

1
2 def menu (meal, special=False):

```

Depending on whether you are defining or calling a function, you call the items in parentheses either “parameters” or “arguments.” When defining a function, the items in parenthesis are **parameters** . When calling a function, the items are **arguments** .

Defining a Function

When defining a function in the **Editor** , the parameters in parentheses specify what types of arguments (values) the function can

accept. In my earlier example, the parameter “special” assigned a default boolean value of “False.” The “special” parameter has a type of “boolean.”

```
def menu (meal, special=False):  
    msg = ""  
1   if special is True:  
2       msg = 'The specials today are  
3       Mimosas. '  
4   if meal == 'breakfast':  
5       msg = 'Breakfast is eggs and  
6       toast. '  
7   else :  
8       msg = 'Sorry, we ran out of food.  
9   '  
    return msg
```

The parameter “meal” has no default value. Because of Python’s dynamic typing, when calling the function, I can pass any type of data for “meal.”

The Python style guide recommends function names begin with a lowercase letter. Class names should begin with an uppercase letter.

The Chapter 6 topic, “The [Function Call Signature](#) ,” explains how to view the parameters accepted by a function. In Chapter 7, Example 20 uses the **signature** function to retrieve parameter information.

Parameters

In this example, there are two parameters in the function definition, “meal” and “special.”

	Parameter Name	Default Value	Required/Optional
Positional	meal		Required
Keyword	special	False	Optional

Table 2.6 Parameters

Arguments

Arguments are the values you pass to a function when calling the function. Not all functions have arguments. In this example, the function has two arguments.

menu ('breakfast', special=True):

Order	Parameter Name	Argument Value
1	meal	breakfast
2	special	True

When I call the this function, the parameters are now referred to as “arguments” because I am calling the function.

Keyword Arguments

The second parameter in my function definition includes the **keyword** “special” with a default value of “False .” When calling a function, a name precedes the keyword argument. List keyword arguments at the end of the parenthesized list, after positional arguments. In this example, the keyword name is “special.”

Positional Arguments

The “meal” argument is a positional argument because it does not have a keyword. List positional arguments before any keyword arguments.

The example below is **invalid** because a positional argument is after a keyword argument.

```
def menu (special=False, meal):
```

Optional Arguments

Because “special” has a default value, when calling the function, “special” is an **optional** argument. If you don’t provide the argument when calling the function, Python uses the default value “False .”

An Arbitrary Number of Arguments

Occasionally, you may need to set an arbitrary number of arguments for a function. Let’s say you have a function to print personalized movie tickets for each patron. The patron names vary from day-to-day. In the next code example, on line 1, there are two **parameters** enclosed in parenthesis:

```
1 def print_tickets(number_of_tickets, *name):
2     i = 0
3     while i < number_of_tickets:
4         print(name[i])
5         i += 1
6 print_tickets(3, 'Carter', 'Rachel', 'Michael')
```

Line 1 includes an asterisk * to indicate there are an arbitrary number of **name** arguments (values) passed to the function.

number_of_tickets

***name**

When I call the function on line 8, I pass it four values or arguments. Three of the arguments are names.

```
print_tickets(3, 'Carter', 'Rachel', 'Michael')
```

How to View the Function Argument Definition

To view arguments accepted by a function or method, you can use the `Help()` function, or inspect the function's **call signature**. For example, to see the arguments of the `meal()` function, run the program to create the function. In the **Console** import the `inspect` library, and type the print statement shown below. The Python Interpreter returns the parameters for the `menu` function.

In [3]: `from inspect import signature`

In [4]: `print(str(signature(menu)))`

`(meal, special=False)`

In [5]:

Calling a Function or Method

When calling a function, you pass arguments with values to the function. Continuing with my example, the last line calls the function “**menu** .”

```
print(menu('breakfast '))
```

```
def menu(meal, special=False):
    msg = ""
    1   if special is True:
    2       msg = 'The specials today are
    3       Mimosas. '
    4   if meal == 'breakfast':
    5       msg = 'Breakfast is eggs and
    6       toast. '
    7   else:
    8       msg = 'Sorry, we ran out of food.
    9       '
   10  return msg
print(menu('breakfast'))
```

The two statements below call the “menu” function and produce the same result. In the second example, I omit the optional argument. When calling the function, the parameter “meal” is referred to as an argument that has a value of “**breakfast** .”

```
menu('breakfast', special=False)
```

```
menu('breakfast')
```

In Chapter 7, Example 6 illustrates an `AttributeError` caused by missing keyword names when calling a method.

Function Return Value

A function returns one object, but that object might be a container like a tuple with several items. When a function doesn't specify a return value, it returns the special value “[None](#) .” For debugging purposes, let's look at the function return object in terms of:

- What **type** of return object does the function return?

- Does the function return a value of “ **None** ?”
- Does the function return a tuple with several items?

All Paths Do Not Have a Return Value

Previously, the example function returned a value on line 9. A return value must exist for all paths through the function. In the next example, I modified the program to have different return values for several paths. The “if” suites of code on lines 5 and 8 both have return values.

```
def menu(meal, special=False):
    msg = ""
1   if special is True:
2       msg = 'The specials today are
3       Mimosas. '
4       return msg
5   if meal == 'breakfast':
6       msg = 'Breakfast is eggs and
7       toast. '
8       return msg
9   else:
10      msg = 'Sorry, we ran out of food.
11
print(menu('lunch'))
```

Do you see the problem with my code? The “else” suite of code beginning on line 9 does not have a return value. When there is no return value, the Python Interpreter returns the value “**None**,” which may not be what you wanted. The topic “Does the Object have a Value of None” in Chapter 6 explains the pitfalls of the value “**None**.” Example 17 in Chapter 7 illustrates how to identify a

More than One Return Value

Occasionally, functions return more than one value. For example, a function may return a tuple or list. In the next example, I pass the function’s return values to **mytxt**. Because the function returns two values on line 10 in a tuple, the Console displays an error.

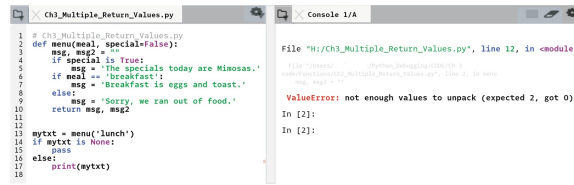


Figure 3.3 Multiple Return Values

To fix my program, I need to change line 17 to print each element in the “**mytxt**” tuple, as shown below.

```
print (mytxt[0 ], mytxt[1 ])
```

The Type of Return Value

The type of return value is especially important if you’re using it as the argument for another function. For example, the “print” function expects a string, and my “**menu**” function returns a tuple. In this case, the Python Interpreter displays a `TypeError`. Using the previous function as an example, in the **Console** I could use the function “type” to identify the type of object the “**menu**” function returns.

```
In [1]: type(menu('lunch'))
```

```
Out [1]: tuple
```

To resolve this error, I use index notation to reference a particular item in the “**mytxt**” tuple returned by the “menu” function.

```
print (mytxt[0 ], mytxt[1 ])
```

3.18 Classes

This topic provides a brief overview of classes. The docs.python.org website has a [tutorial](#) on classes and explains the concept of “self” in great detail.

- Create a Class
- The DocString
- Variables - Attributes
- Create an Instance of the Class

- Methods
- Dotted Notation for Attributes
- Calling a Method

```

class Car():
    """This class represents a car."""
1   yr = 2020
2   def __init__(self, model, make, year):
3       """Initialize model, make, and year
4       variables."""
5       self.model = model
6       self.make = make
7       self.year = year
8   def drive(self):
9       """Move the car."""
10      print(self.model.title() + " is now
11      moving.")
12  def parallelpark(self):
13      """Parallel park the car."""
14      print(self.model.title() + " is now
15      parking.")
16
17  my_car = Car('Subaru', 'Crosstrek', 2019 )
    print(my_car.model, my_car.make,
          my_car.year)
    my_car.parallelpark()

```

Create a Class

In this class example, the first line creates a class named “Car.” Class names begin with a capital letter, to differentiate them from function names which should be lowercase.

The DocString

Lines 2, 5, 10, and 13 look like comments, but are actually examples of a “DocString.” The Chapter 6 topic, “The [Function Call Signature](#),” explains how to work with the “inspect” module and view a DocString signature.

The function help() reads the [docstring](#) when gathering information about an object.

Variables - Attributes

Beginning with the function definition on line 4, you can see the four parameters in the class.

```

def __init__( self, model, make, year):
    self
    model

```

```
make
year
```

When working with the “my_car” instance of the Car class, use dotted notation to reference the variables.

```
my_car.model
my_car.make
my_car.year
```

When referring to the state of an object, you are referring to variables or **data attributes** . The variables **model** , **make** , and **year** on lines 6, 7, and 8, respectively, are accessible through instances.

```
self.model = model
self.make = make
self.year = year
```

The statement below is invalid because there is no attribute named “**color**. ” When I run this program, the Python Interpreter displays an **AttributeError** in the **Console** .

```
my_car.color
```

In Chapter 7, Example 6 illustrates an error with an incorrect call for a class method, which causes an **AttributeError**.

Instance Variables and Class Variables

Instance variables are unique to each instance of the class. For example, **my_car.model** is different than **my_car2.model** . All instances of a Class share class variables and methods. For example, all instances of the **Car** class share the class variable “**yr** ” I created on line 3.

Create an Instance of the Class

[Instantiation](#) is when you create an instance of an object from a class. On line 15, I create an instance of the Car class named “**my_car** .”

```
my_car = Car(‘Subaru’, ‘Crosstrek’, 2019 )
```

Instance objects have attribute references. Valid attribute names

include “**data attributes** ” and “**methods** .”

Methods

A function that is part of a class is called a “**method** .” When referring to the behavior of an object, you are discussing the function or method. The “Car” class has two methods, defined in lines 11 and 15. The “drive” method is shown below.

```
def drive(self):  
    """Move the car."""  
    print(self.model.title() + “ is now moving.”)
```

Dotted Notation for Attributes

The normal dotted notation “**object.variable** ” is used to access the instance of the class (the object) and the attribute. In this example, the syntax is “**my_car.model** .” The primary object instance is “**my_car** ,” and the attribute identifier name is “**model** .” To refer to the model, make, or year attributes follow the syntax on line 21, as shown below.

```
print(my_car.model, my_car.make, my_car.year)
```

Calling a Method

To call a method in a class instance, use the syntax shown in line 17.
`my_car.parallelpark()`

At the end of this book, the **Appendix - Reference** has links for more information on Classes, Functions, Methods, Attributes, and Instances.

These two statements call a method. The statement syntax varies, but the statements do the same thing.

```
Car.drive(my_car)
my_car.drive()
```

3.19 Attributes

The Chapter 4 topic, “[Variables and Objects in Memory](#),” discusses the current namespace and the concept of attributes. The Python glossary entry for “attributes” is “a value associated with an object which is referenced by name using dotted expressions.”

In the Chapter 2 example, we looked at a line of code with a number variable.

```
myint = 57
print(myint.upper)
```

When the program runs, it causes an unhandled exception, and the **Console** Traceback message is “**AttributeError**,” because there is no attribute “upper” for a variable of type “int.”

When looking at Classes in this chapter, we saw that attributes could be variables or methods within a class instance. In our earlier Class example, we saw that instance objects have attribute references. Valid attribute names include “**data attributes**” and “**methods**.” In this example of attributes, “**yr**” is a class variable, and “**drive**” is a method in the **my_car** instance of the “**Car**” Class.

```
my_car.yr
my_car.drive
```

4. Debugging Tools

In this chapter we discuss

Debugging Overview

Add Print Statements to Your Script

Debug Mode

Variable Explorer

Example: Program Loops and Never Ends

Debug Commands

Interactive Mode

Introspection

Logging

The `timeit()` Function

Focused Testing

Create Test Data

This chapter outlines a few ways to use the Spyder IDE to debug your program. With a few simple commands, there is a wealth of information available about your variables, functions, data structures, and more. We'll look at:

- Adding Print Statements to code in the Editor, and viewing the results in the Console (the Python Shell.)
- Using Debug Mode in Spyder.
- Using Interactive Mode in the **Console** .

4.1 Debugging Overview

When debugging code, I inspect values, types, function arguments, and function return objects. “Introspection” functions like `help()` and `dir()` also provide information on methods, functions, and objects. There are also libraries for “logging” and functions to identify bottlenecks and timing issues. Finally, I’ll demonstrate how to focus on a specific area of code for testing and how to create test data.

To begin, I’ll look at several ways to debug my code.

- Inspect Objects and Variables
- Add Print Statements to a Script
- Debug Mode
- Variable Explorer
- Interactive Mode

In the Editor, add **print statements** to your script, and run the program. The **Console** , also known as the Python Shell, displays the results of print statements.

In the Run menu select  “Run selection or current line” to run only the selected lines of code.

Run your program in Debug mode , stepping through the lines of code. The Console prompt changes to **ipdb** in **Debug mode** . In Debug Mode, you step through the lines of code, pausing to look at the **Variable Explorer** pane or type commands at the **Console** prompt, to inspect object values.

The Editor pane highlights the current line. This line executes when you click “run current line” on the debug toolbar. The Variable Explorer displays the values of each variable in the current context.

Interactive Mode in the Console allows you to type commands that display object values. In the Console type the name, or identifier, of the object. The Python Interpreter returns the value of the identifier. The object can be an integer variable, a list item, tuple, or another type of

object.

In the **Console** , you can also run individual lines of code while developing or testing your code. Interactive Mode is a great way to test code before adding it to your script. You can also set a “breakpoint” to move to a particular location in your program.

The topic “Variables and Objects in Memory” outlines how Python creates variables and objects when you run a program or script. If you type your object name in the Console and the Traceback says “NameError,” insure that you ran the line of code that creates the object.

4.2 Add Print Statements to Your Script

A popular debugging choice is to add print statements to your code. A print statement is a quick and easy way to inspect an object’s type, value, and length, while your code is running. Add a print statement to your script in the **Editor** window, and on the **Run** menu execute your program. The **Console** displays output from the print statement. The Console is the Python Shell.

A quick and easy way to debug a program is to add print statements to your code. In the next example, I added two print statements to help me follow my running code.

```
meals = ['breakfast', 'lunch', 'snack', 'dinner']
1 ]
2 fruits = ['apple', 'orange', 'grape']
3 i = 0
4 while i < 4:
5     j = 0
6     print("my meal is: ", meals[i])
7     while j < 4:
8         print("My choice of fruit is: ",
9             fruits[j])
10        print("j is: ", j)
11        j = j + 1
12    i = i + 1
```

In [1]: my meal is: breakfast
my meal is: breakfast
my meal is: breakfast
my meal is: breakfast
my meal is: breakfast
my meal is: breakfast
my meal is: breakfast



Try This 6.1 *Print Statements*

While marginally helpful, the print statements in the Console window quickly scroll by because this program is in an infinite loop. Scrolling output is where Debug Mode or Logging comes into play, and we'll look at both in the next sections.

In Chapter 7, Example 15 uses print statements with exception handling logic. Chapter 6 explores the syntax to view an object's type, length, and value.

Indenting Loop Print Statements

Another print option is "indenting" the print statements each time the program loops through a Suite of code. In Python, a "[Suite](#)" of code is a block of indented code, as discussed in Chapter 3. These print statements provide a visual representation of how many times the loop has run.

```

meals = ['breakfast', 'lunch', 'snack', 'dinner']
1]
2]fruits = ['apple', 'orange', 'grape']
3]i = 0
4]level = ""
5]while i < 4:
6]    level = level + ".... "
7]    print("my meal is: ", fmeals[i])
8]    i = i + 1

```

In this example, the **Console** shows the print output with a series of dots representing the depth of the loops. I use the “level” string variable to create the effect.

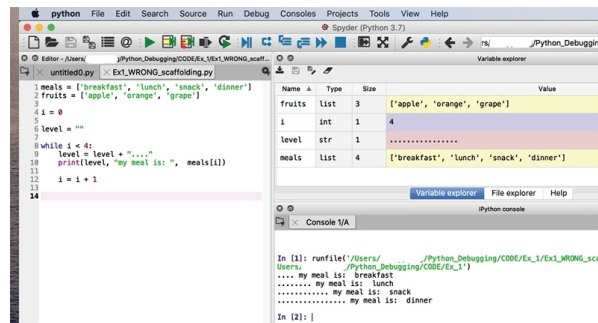


Figure 4.1 Indenting Loop Print Statements

4.3 Debug Mode

Use the **Debug** menu commands to step through the lines of code, or press Cntrl + F12 on a Windows computer to move to the next breakpoint. The Variable Explorer displays object values, changing over time as you step through the program code.

In the **Editor**, double click on a line of code to set a **breakpoint** or press F12 on a Windows computer. When running a program in Debug Mode, a breakpoint pauses the program at that point, so that you can inspect the variable and object values. A red dot appears to the left of the line number with the breakpoint.

On the **Debug** menu, select ‘debug’ to launch the iPython debugger, or press Cntrl + F5 on a Windows computer. The prompt in the **Console** changes to **ipdb>**, indicating the iPython debugger is active.

If a program halts and displays a Traceback error, you can type **%debug** to start “Debug Mode.” Functions that begin with the

percent symbol are “magic functions .”

In the next example, there is a breakpoint • on line 3. The figure shows the **Editor** pane, as well as the **Console** pane after I pressed Cntrl + F5 on a Windows computer to start debugging. Notice the **Console** prompt changed to **ipdb>** .

```
1 mystring = "purple peanuts"
2 print (mystring)
3

In [1]: debugfile('C:/SampleScript.py',
wdir='C:')
>C:\SampleScript.py(1)<module>()
---->1 mystring = "purple peanuts "
      2
      3 print (mystring)
ipdb>
ipdb>
```

Table 4.1 Setting a Breakpoint

In the **Console** pane, an arrow indicates the current line number, in this case, line 1. If Variable Explorer is not already open, on the **View** menu select “Panels,” and then click on Variable Explorer. As I “**step-through**” the code, I want to watch the “mystring” object in Variable Explorer. At this point, the Variable Explorer is empty because we have yet to run the first line of code.

As you step through the code, the Editor highlights the current line.

Click the icon  to **Run the current line of code** or press **Ctrl + F10** on a Windows computer. The Python interpreter creates the object “mystring” and assigns the value “purple peanuts.” This example of dynamic typing is one of the reasons I love Python. With one line of code, Python figures out the type of object to create and assigns a value.

In Chapter 7, Example 2 illustrates Debug Mode.

End Debug Mode

To exit the debugger, type **q** or **quit** at the **Console** prompt and press enter, as shown below. If you are in an [iPython Session](#) in the **Console**, you may have to press enter several times to quit Debug Mode, or type **Esc + Enter**. You can also restart the kernel when you select “Restart Kernel” from the **Consoles** menu.

```
ipdb>C:\SampleScript.py(1)<module> >
()
1 mystring = "purple peanuts "
2
---->3 print (mystring)
ipdb>
```



```
ipdb>quit  
In [2 ]:
```

Table 4.2 Quit Debug Mode

4.4 Variable Explorer

Now, **Variable Explorer** displays a row with the type of the “mystring” object, and the value I assigned in line 1.

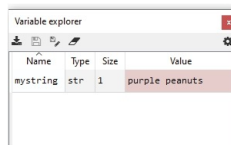


Figure 4.2 The Variable Explorer Pane

Variable Explorer shows [variables and objects in memory](#) . If you don’t see your object displayed in Variable Explorer, you need to execute that part of the program. To start fresh, in the **Console** use the magic command **%Reset** . See the earlier topic “Variables and Objects in Memory.” In Chapter 7, Examples 1-3 demonstrate using the Variable Explorer.

4.5 Example: My Program Loops and Never Ends

Let’s briefly look at an example of **Debug Mode** in action. When I run this test program, it never ends. In other words, it loops continuously. My hypothesis is the while loop that begins on **line 8** needs adjusted. First, I’ll stop the running program. Next, I’ll use Debug Mode to step through the code and identify what is happening.

1. On the **Consoles** menu, select “Restart Kernel” to interrupt the running program.
2. Double click to the left of line 9 to add a breakpoint. A **red** dot appears to the left of the line number.
3. On the **Debug** menu, select “Debug” or click on the Debug control.

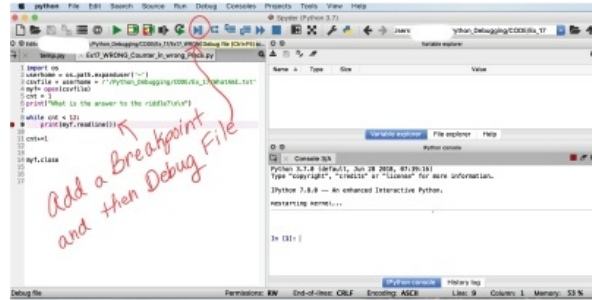


Figure 4.3 Add a Breakpoint

4. The **Console** prompt changes to **ipdb>** to indicate the iPython Debugger is active, and the **Variable explorer** displays values for the current active variables. Right now, the variable **cnt** has a value of **1** . The Console displays a few lines of the code, with an arrow indicating the current line 9. Line 9 runs when I click on “Continue Execution.”

The Debug Mode commands “u” or “up” move backward in your program. These commands are useful to find where the value was assigned to a variable.

5. When I click on “Continue Execution” again, line 9 runs and loops back to line 8. The variable **cnt** still has a value of **1** . At this point in the program, I wanted the value of **cnt** to be 2.

If I use the command “Run Current Line,” in the Console pane, I can see the program moving continuously from line 8 to 9 and then looping back to 8. This program is in an infinite loop.

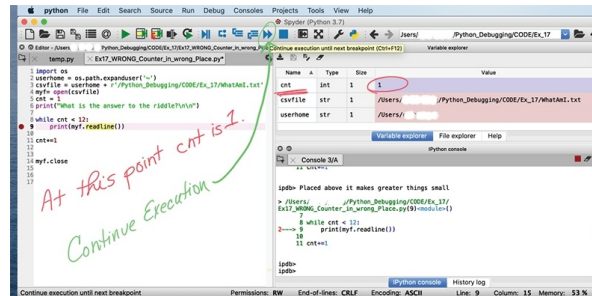


Figure 4.4 Continue Execution

- To resolve the issue, I need to indent line 11, so this statement that increments the **cnt** variable is part of the while loop. The concept of a "Suite" of Indented Code was discussed in Chapter 3.

In the next figure, the output is correct in the **Console** . In the Editor pane, you can see line 11 is now indented.

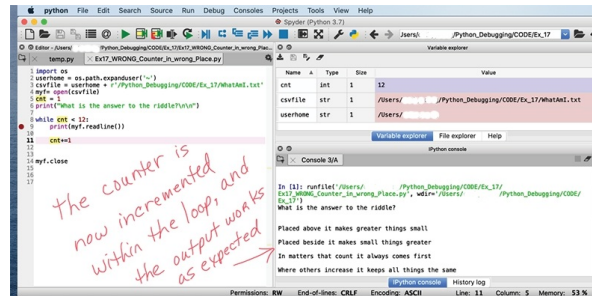


Figure 4.5 The Finished Program

To complete the program, I could add a print statement with the answer to the riddle - the number one.

In Chapter 7, Example 1 demonstrates an infinite loop.

4.6 Debug Commands

In Debug Mode, type `?` in the **Console** prompt `ipdb>` and press enter to see a list of Debug Commands. A brief list of popular commands is shown below.

`ipdb> ?`

For specific details on a particular command, type `help`, and the command name. For example, type `"help next ."`

`? Help with Debug commands`

`b` or **break** Add a break

`c` Continue

`cl` or **clear** Clear breaks

`d` or **down** Move down in the stack trace

`exit` Exit Debug Mode

`h` or **help** Help on Debug Mode

`j` or **jump** Jumps to line number with a block of code

`n` or **next** Move to next line

`u` or **up** Move up in the stack trace

`q` or **quit** Exit Debug Mode

4.7 Interactive Mode

Another option to view object values involves typing in the **Console** in **Interactive Mode**, which is similar to typing in the **Console** while in Debug Mode. In the **Console**, type the identifier (the name) of the object. The Python interpreter displays the value in the **Console**, as shown below.

```
In [ 1 ]: mystring
```

```
Out[1]: 'purple peanuts'
```

You must run the program statement that creates or sets the object value in the current namespace before the Python Interpreter, or Variable Explorer, can display a value.

While in **Debug Mode**, you can type the name of an object in the **Console**, and the Python Interpreter displays the value. This “Interactive Mode” also allows you to perform calculations or use functions and methods, as shown in the next example.

```
ipdb> mystring
'purple peanuts'
ipdb> 2+3
5
ipdb> import math
ipdb> math.sqrt(16)
4.0
ipdb>
```



Table 4.3 Type in Console While in Debug Mode

The iPython kernel also has several “magic commands” that begin with the % character.

```
%debug
```

```
%reset
```

In Chapter 7, Example 1, Example 2, and Example 6 demonstrate Interactive Mode.

Increment Counters in the Console



One of my **favorite debugging shortcuts** is to change a counter so that I can move forward when I'm looping through the code. For example, I can change a "while loop" to move from the 2nd iteration to the 1200th iteration. Let's say I'm in debug mode, and my program pauses at a breakpoint where my "bfr" counter = 2. In the Console, I would increment the "bfr" counter by typing **bfr =1200** .

Watch Out for Changing Values

While most functions or methods provide useful results when typed in the Console, you can get unexpected results. In Chapter 7, Example 17 reads a TXT file with the OS library. **Readline()** moves to the next line of the TXT file on its own every time you type it in the Console, which may not be what you were expecting.

iPython Session

The **Console** prompt changes to three dots and a colon **...:** to indicate you are in an **iPython Session** . Press enter twice, or press **Esc + Enter** , to exit the iPython session.

```
In [1]: def myfunction(str)
```

```
...: print(str)
```

When the newline prompt **...:** is displayed, press Shift Enter to execute the commands.

4.8 Introspection

Introspection is the ability to determine the type of the object at runtime. Several functions help with introspection, as well as the "**inspect**" library.

objectname ?

```
dir()
help()
id()
repr()
type()
```

To inspect objects, we'll execute statements in the **Editor** and **Console**, including statements with “Introspection” functions that provide details about objects. The syntax varies depending on whether you are typing in the **Editor** or **Console** pane. The syntax is also specific to the type of object. We'll look at those differences in depth in Chapter 6. In the case of data structures like Lists, Tuples, or Dictionaries, you may want to see values for the entire List or the value of only a particular List item.



Editor



Console (Python Shell)

Variables and Objects in Memory

The Python Interpreter creates variables and objects when you run a program or script. The collection of these objects in the **Console** is the “**Namespace**.” If you're debugging a line of code and a function uses an object, you want to ensure the object exists in memory before trying to view the object in **Variable Explorer**. The Variable Explorer shows active variables in memory. Take, for example, this line of code that uses a variable “**myint**” of type “int.”

```
myint = 57
print(myint.upper)
```

If the program ran and created “myint” already, the **Console** Traceback message is “**AttributeError**,” because there is no attribute “upper” for a variable of type “int.” **If the program hasn’t run and created the variable “myint,”** the **Console** Traceback message is “**NameError**.” In this example, a misleading Traceback message “NameError” is hiding the Traceback message you want to see, “AttributeError.”

When you change a function definition and want to use the new version of the function, you can run just that part of your code. In the Run menu select  “Run selection or current line” to run only the selected lines of code.

Use the `%reset` [magic command](#) in the **Console** to reset the namespace.

Using ? in the Console

For details on any object, in the **Console** type the object name followed by a question mark. For details on the object “**myfunction**,” in the **Console** type the function name followed by a question mark, as shown below. The output includes the Signature, DocString, and Type of object.

```
In [2]: myfunction?
```

```
Signature: myfunction(str)
```

```
Docstring: <no docstring>
```

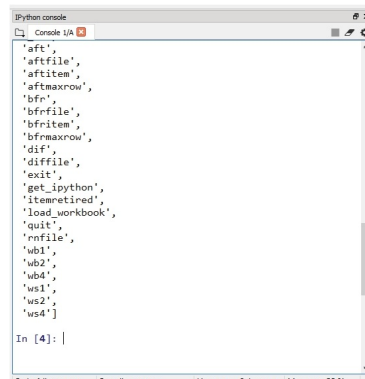
```
File: ~/Python_Debugging/CODE/Ch 3 code/Functions/<ipython-input-8-df3069fd62ae>
```

```
Type: function
```

dir()

The function **dir()** displays all objects in the current local [namespace](#), as shown in the next figure. After running the sample “*Project1.1.py*” script, the local scope changes. This script uses the “openpyxl” library to create the **ws4** object. For example, after running the “*Project1.1.py*” script, the `dir()` function displays relevant information about the program objects in the **Console**. Type the `dir()` command in the **Console** window.

In [2]: dir()



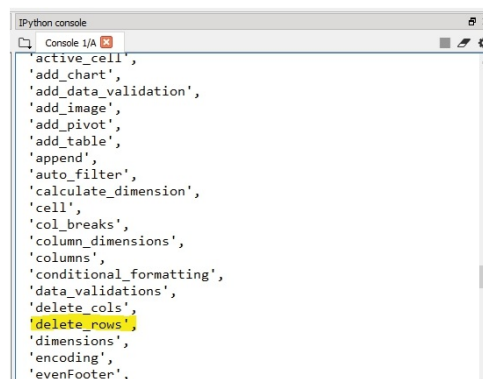
```
Python console
Console 1/A
'aft',
'aftfile',
'aftitem',
'aftmaxrow',
'bfr',
'bfrfile',
'bfritem',
'bfrmaxrow',
'dif',
'diffile',
'exit',
'get_ipython',
'itemretired',
'load_workbook',
'quit',
'rnfile',
'wb1',
'wb2',
'wb4',
'ws1',
'ws2',
'ws4']
In [4]:
```

Figure 2.5 Objects in Current Local Scope

At this point, the function results aren't exactly exciting. Type `dir(ws4)` in the **Console** window to display attributes specific to the **ws4** object. The `dir()` function displays different attributes depending on the type of object.

There is quite a long list of valid attributes for the **ws4** object, and the next example only shows a few of the attributes. In particular, I'm interested in what functions I can use with the **ws4** object, and I've highlighted the “**delete_rows**” method.

Note, if you're using an older version of Python, “**delete_rows**” might not be available. The `dir()` function is an easy way to check if a particular function or method should work with your code.



```
IPython console
Console 1/A
'active_cell',
'add_chart',
'add_data_validation',
'add_image',
'add_pivot',
'add_table',
'append',
'auto_filter',
'calculate_dimension',
'cell',
'col_breaks',
'column_dimensions',
'columns',
'conditional_formatting',
'data_validations',
'delete_cols',
'delete_rows',
'dimensions',
'encoding',
'evenFooter',
```

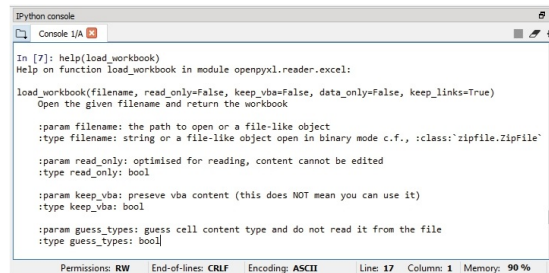
Figure 2.6 Valid Attributes for the ws4 Object

help()

The `Help()` function invokes the help system for help with a module,

function, class, method, keyword, or documentation topic. For example, when I type `help(load_workbook)` in the **Console** window, Python displays information specific to the method “load_workbook” from the “openpyxl” library.

In [2]: `help(load_workbook)`



```
Python console
Console 1/A
In [7]: help(load_workbook)
Help on function load_workbook in module openpyxl.reader.excel:

load_workbook(filename, read_only=False, keep_vba=False, data_only=False, keep_links=True)
Open the given filename and return the workbook

:param filename: the path to open or a file-like object
:type filename: string or a file-like object open in binary mode c.f., :class:`zipfile.ZipFile`
:param read_only: optimised for reading, content cannot be edited
:type read_only: bool
:param keep_vba: preserve vba content (this does NOT mean you can use it)
:type keep_vba: bool
:param guess_types: guess cell content type and do not read it from the file
:type guess_types: bool
```

Figure 2.7 Help for load_workbook Method

The Inspect Library

Use the “[Inspect](#)” library for additional information on an object, including the Docstring or call signature of a function or method. There are many functions available in the library. Details are available on the docs.python.org website.

```
In [3]: from inspect import signature
In [4]: print(str(signature(load_workbook)))
(filename, read_only=False, keep_vba=False, data_only=False, keep_links=True)
```

The type() Function

In the Chapter 3 topic, “[What is the Data Type?](#),” we used the **type()** function to examine the type of an object. Chapter 6 also includes numerous examples using the type() function.

```
print( type( my_var ) )
```

The id() Function

When dealing with immutable objects or scope issues, the **id()** function is useful in isolating which object you are referencing. Scope has to do with global vs. local variables.

```
print( id (bfr))
bfr = bfr + 1
print( id (bfr))
```

The repr() Function

The **repr()** function returns a string representation of an object, and is useful in finding “whitespace.”

The len() Function

The len() function shows the length of the string or the number of items in a data structure. For example, len(mydictionary) would return the number of Dictionary key pairs. len(mylist) would return the number of items in the List.

4.9 Logging

Logging is a simple way to capture debugging data. Use logging when the output in the **Console** pane scrolls and is lost because there is too much data. Logging is also useful when you're working out code logic, or have a live program with user reports of erratic behavior.

This script has a logging level set to ERROR, which means it logs errors and critical events. For a thorough look at logging, please refer to the docs.python.org .

```
logging.basicConfig(format='%(asctime)s - %(message)s',
                    datefmt='%d-%b-%y %H:%M:%S',
                    filename='test.log',
                    level=logging.ERROR)
```

When there is an exception on line 9 in the statement **10/my_int** , the Python Interpreter logs a critical error to the **test.log** file.

```
import logging
1 logging.basicConfig(format='%(asctime)s - %
2 (message)s',
3     datefmt='%d-%b-%y %H:%M:%S',
4     filename='test.log',
5     level=logging.ERROR)
6 logging.error('The logging level is ERROR and above.')
7 my_int = 0
8 try :
9     10 /my_int
10 except Exception:
11     logging.critical("my_int is %s", my_int,
        exc_info=True)
```

The first time you run the program the logfile **test.log** is created. The default mode is “append.” If the log file is not created, try restarting Spyder. This is the output in the log file.

```
29-Jan-19 10:29:33 - Logging level is ERROR and above.
29-Jan-19 10:29:33 - my_int value is 0
Traceback (most recent call last):
  File "/Ch 4 code/Logging/logging.py", line 13, in <module>
    10/my_int
ZeroDivisionError: division by zero
```

To disable logging, use the “disable” method with the appropriate argument, as shown below.

```
logging.disable(logging.CRITICAL)
```

To enable logging again, use the “disable” method with the “NOTSET” argument.

```
logging.disable(logging.NOTSET)
```

4.10 The timeit() Function

The `timeit()` function can identify bottlenecks in your code. Let's say we want to time this block of code.

```
colors = ('blue', 'red', 'green')
for color in colors:
    print(color)
```

Import the **timeit** module. Create a string “**mycode** ” that encloses the code statements in triple quotes. In the example below, the last line invokes the **timeit** method to run the code 100 times.

```
1 from timeit import timeit
2 mycode = """
3 colors = ('blue', 'red', 'green')
4 for color in colors:
5     print(color)
6 """
7 print(timeit(stmt=mycode, number=100))
```

4.11 Focused Testing

Sometimes I need to focus on one part of my code, to the exclusion of other areas. By providing test data for the steps I'm excluding, I can focus on the defect. Let's look at my program that has five tasks.

1. Get KDP royalties.
2. Get the GBP exchange rate.
3. Calculate total sales for the month.
4. Calculate the average daily sales for the month.
5. Calculate the expected monthly sales.

Actual Result

When I run the code, the program halts. The Traceback shows a `ZeroDivisionError` on line 65. I haven't changed anything in the program in several weeks. Until today the program ran successfully. This is the code on line 65.

```
    dailysales = (total/myday)
```

Incorrect Code

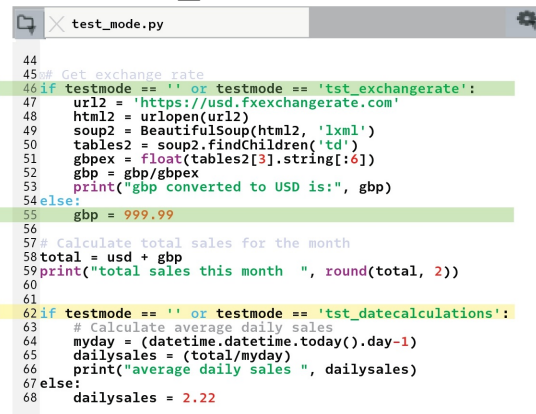
The value of “**myday** ” is set on line 64, as shown below. As it

happens, on the first day of the month, the statement on line 64 evaluates to zero.

```
myday = (datetime.datetime.today().day-1)
dailysales = (total/myday)
```

While this particular example is easy to troubleshoot, when you have a program with external connections, it can be a challenge to isolate the defect. With a slight modification, I can use a variable “**testmode**” as a switch to use test values. When I want to test ‘datecalculations,’ I set all the other conditional statements to use test data. In effect, I remove all the other code from the equation and only run lines 62-68.

For example, the “else” statement on line 54 sets **gbp** to a value of 999.99 when **testmode** is “**tst_datecalculations** .”



```
44 # Get exchange rate
45 #
46 if testmode == '' or testmode == 'tst_exchangerate':
47     url2 = 'https://usd.fxexchangerate.com'
48     html2 = urlopen(url2)
49     soup2 = BeautifulSoup(html2, 'lxml')
50     tables2 = soup2.findChildren('td')
51     gbpx = float(tables2[3].string[:6])
52     gbp = gbp/gbpx
53     print("gbp converted to USD is:", gbp)
54 else:
55     gbp = 999.99
56
57 # Calculate total sales for the month
58 total = usd + gbp
59 print("total sales this month ", round(total, 2))
60
61
62 if testmode == '' or testmode == 'tst_datecalculations':
63     # Calculate average daily sales
64     myday = (datetime.datetime.today().day-1)
65     dailysales = (total/myday)
66     print("average daily sales ", dailysales)
67 else:
68     dailysales = 2.22
```

Figure 4.6 test_mode.py

4.12 Create Test Data

Use the smallest subset of data possible for testing. After removing a chunk of data, ensure you still have enough data for your program to function. If you’re debugging an error, be careful to keep the data that recreates the error.

In this example, I changed the code on line 13 and created an HTML data file. Rather than connecting to a live website, I copied the “HTML” data to a file. I also removed unnecessary headings and tables from the HTML file.

```

test_data.py
12 # get kdp royalties
13 html_file = open('kdproyalties.html', 'r')
14 source_code = html_file.read()
15 soup = BeautifulSoup(source_code, 'html.parser')
16 tables = soup.findChildren('table')
17 mytable = tables[0]
18 rows = mytable.findChildren(['tr'])
19 for row in rows:
20     currency = row.findChildren()[4].string
21     if currency == 'USD':
22         mymoney = (row.findChildren()[13].string)
23         usd = usd + float(mymoney.replace(',',''))
24     if currency == 'GBP':
25         mymoney = (row.findChildren()[13].string)
26         gbp = gbp + float(mymoney.replace(',',''))
27
28
29 # Get exchange rate
30 html2 = urlopen('https://usd.fxexchangerate.com')
31 soup2 = BeautifulSoup(html2, 'lxml')
32 tables2 = soup2.findChildren('td')
33 gbpx = float(tables2[3].string[:6])
34 gbp = gbp/gbpx
35
36

```

Figure 4.7 Test Data.py File

Below is a small excerpt of the html data, with the data I need for my program.

```

try and except.py  royalties_divide_and_conquer.py  kdproyalties.html
56 </tr>
57 <tr>
58 <td valign="middle" class="td1">
59 <p class="p2"><span class="s1">Amazon.co.uk</span></p>
60 </td>
61 <td valign="middle" class="td2">
62 <p class="p2"><span class="s1">GBP</span></p>
63 </td>
64 <td valign="middle" class="td3">
65 <p class="p2"><span class="s1">0.00</span></p>
66 </td>
67 <td valign="middle" class="td4">
68 <p class="p2"><span class="s1">0.00</span></p>
69 </td>
70 <td valign="middle" class="td5">
71 <p class="p2"><span class="s1">2.43</span></p>
72 </td>
73 </tr>
74 <tr>
75 <td valign="middle" class="td1">
76 <p class="p2"><span class="s1">Amazon.de</span></p>
77 </td>
78 <td valign="middle" class="td2">
79 <p class="p2"><span class="s1">EUR</span></p>
80 </td>
81 <td valign="middle" class="td3">
82 <p class="p2"><span class="s1">0.00</span></p>
83 </td>
84 <td valign="middle" class="td4">
85 <p class="p2"><span class="s1">0.00</span></p>
86 </td>
87 <td valign="middle" class="td5">
88 <p class="p2"><span class="s1">0.00</span></p>
89 </td>
90 </tr>
91 <tr>
92 <td valign="middle" class="td1">

```

Figure 4.8 Test HTML Data File

5. Exceptions

In this chapter we discuss

Kinds of Errors

The Stack Trace or Traceback Message

Try and Except

Raise

Assert

Built-in Error Types

To begin our discussion of exceptions, we'll look at the basic kinds of programming errors. When I say "kind" of error, this is just a general classification to characterize programming errors. When an event happens that the Python Interpreter can't process successfully, it stops the program with an exception.

After an unhandled exception occurs, the Python Interpreter displays the stack trace in a "**Traceback**" message in the **Console** pane with details about the exception. In the topic, "Traceback Message," you'll see there is a wealth of information in a Traceback message. Often the Traceback message immediately points to the cause of the error.

To handle exceptions, you can add "**try and except**" statements to deal with exceptions gracefully. For critical events, we'll look at the "**raise**" command where you raise your exception. When an object must be a certain value, adding an "**assert**" statement to trigger an exception is a great time saver.

Finally, we'll briefly look at the Python built-in exceptions you're likely to encounter when programming in Python.

5.1 Kinds of Errors

Generally, when things go wrong in a program, they fall into one of three categories.

- Syntax Errors
- Logic or Semantic Errors
- Runtime Errors

Syntax Errors are usually obvious, and the Spyder Editor points out Syntax errors with a yellow triangle. Runtime errors occur when the Python Interpreter halts and displays an exception. I find my "Logic" errors the most difficult to identify because the program does what I told it to, but my initial design or logic is flawed.

Syntax

A syntax error is raised by the parser when the parser encounters a syntax error. The Spyder Editor makes it virtually impossible to have Syntax errors. A yellow triangle appears to the left of the line number if there is a Syntax error in the code.

Chapter 7 demonstrates syntax errors in Example 5, and Examples 7-12.

Logic or Semantic

With a logic error, the flaw is with me. I told the program to do something, but it's not the outcome I want. To identify logic errors, I find it helpful to go back to the drawing board and look at my initial "Intended Outcome" or pseudocode. Pseudocode is an outline of your program design in simple terms, often written in plain English.

Runtime

The challenge with debugging runtime errors is a line (or suite) of code runs as expected several times, and then suddenly halts with an error. As a program runs, variable values change. Another example of a RunTime error is when a program takes too long to run.

While general RunTime errors are flagged as a “RunTimeError” by the Python Interpreter, what I am referring to as “Runtime” is the overall kind of error. The actual Traceback message displayed in the Console may vary, as shown in Chapter 7 in Examples 5 and Examples 7-12.

To research a runtime error, we need to look at the values at the moment the error occurred. When looking at values, you may have a critical variable that must be a certain value for your code to function. Assert statements halt the program and warn you when values are outside the parameters you require.

Another example of a Runtime error is a chunk of code that takes too long to run. In this case, the function “timeit” times program execution.

- Debug Mode
- Variable Explorer
- Interactive Mode
- Print Statements

Chapter 7 looks at these kinds of errors in Examples 1, 4, 6, 14, 15, and 17.

5.2 The Stack Trace or Traceback

The Traceback includes this basic information.

- File
- Line Number
- Module
- Exception
- Exception Description

The next lines are a sample **Console** Traceback. I abbreviated the file path for readability.

```
File "workbook.py", line 289, in __getitem__  
    raise KeyError("Worksheet {0} does not exist.".format(key))  
KeyError: 'Worksheet Sheet1 does not exist.'
```

The Traceback details are as follows:

```
File: "workbook.py"  
Line Number: 289  
Module: __getitem__  
Exception: KeyError  
Exception Description: Worksheet Sheet1 does not exist.
```

This Traceback information provides the clues needed to research many issues. In Chapters 6 and Chapter 7, I'll often refer back to the Exception in the Traceback.

Chapter 7, Examples 1, 2, 3, and 6 demonstrate traceback screens.

Don't Be Fooled

A misleading Traceback message "NameError" could be hiding the Traceback message you want to see. In the Chapter 4 topic, "Variables and Objects in Memory," we looked at how the Python Interpreter creates variables and objects when you run a program or script. In this example, there is a variable "myint" of type "int."

```
myint = 57  
print(myint.upper)
```

If the program ran and created "myint" already, the **Console** Traceback message is "AttributeError" because there is no attribute "upper" for a variable "myint." If the program hasn't run and created the variable "myint," the **Console** Traceback message is "NameError."

When the program encounters an Out of Memory error, the Traceback exception is rarely the actual cause of the defect.

5.3 Try and Except

Unhandled exceptions halt the program and display a Traceback with an exception error. When you add "try" and "except" statements to your

code, you can control how exceptions are handled, and prevent your program from unexpectedly halting. In this next example with “except,” you can see where I added custom messages.

```

try :
    gbpx = float(tables2[3 ].string[:6 ])
    gbp = gbp/gbpx
    print("gbp converted to USD is:", gbp)
except TypeError:
    print("Type error when converting exchange rate")
except ZeroDivisionError:
    print('ZeroDivisionError where gbpx is:', gbpx)
except Exception as exceptdetails:
    print(exceptdetails, 'gbpx is:', gbpx)
finally :
    print("Done calculating the gbp exchange rate.")

```

The **finally** clause at the end runs whether the **try** clause has an exception or not.

5.4 Raise

At any point, you can add your own “raise” statements in your program to raise an exception, as shown below.

```
raise Exception("I broke my program.")
```

5.5 Assert

When your program depends on a statement to be true, consider adding an “assert” statement to alert you if the statement does not evaluate to “true.” When I was calculating KDP royalties earlier, I found the GBP exchange rate on a web site. In order for my program to calculate GBP royalties in USD currency, “**gbpx** ” must be greater than zero.

```
assert gbpx > 0 , 'gbpx must be > ' + str(gbpx)
```

Now when my program runs and “**gbpx** ” is not greater than zero, an exception is raised. The **Console** displays a Traceback message, as shown below.

```
AssertionError: gbpx must be > 0
```

5.6 Built-in Error Types

The following list of built-in exceptions is a reference for the examples that follow. For a complete list of exceptions, visit <https://docs.python.org/3/library/exceptions.html> .

ArithmeticError

ArithmeticError is the base class for built-in exceptions for various arithmetic errors.

AssertionError

An **AssertionError** is raised when the [assert](#) statement fails.

AttributeError

The **AttributeError** is raised on attribute assignment or when the reference fails. When an object does not support attribute references or attribute assignments at all, a **TypeError** is raised. For example, an “int” object has no attribute “upper.” The code below would cause an **AttributeError** :

```
myint = 57
print(myint.upper)
```

Because a “string” object does have an attribute “upper,” this code for a string is valid.

```
mystr = 'age'
print(mystr.upper())
```

To view attributes of an object named “**mystr** ” run the program, then type “**dir(mystr)** ” in the Python **Console** . You must run the program for the Python Interpreter to create the variable “mystr.” **If you haven’t run the program** , the Python Interpreter displays a **NameError** exception. See Chapter 7, Example 6, for a description of debugging an **AttributeError** .

In Chapter 7, Example 6 demonstrates an AttributeError.

In Python, Objects have attributes. So, for example, the object “**ws1**” has an attribute named “**.cell**.” In this example, the dotted notation would be **ws1.cell()** .

EOFError

Raised when the input() function hits the end-of-file condition without reading any data. In Chapter 7, Example 15 demonstrates an EOFError.

FloatingPointError

Raised when a floating-point operation fails.

ImportError

When Python Interpreter has trouble loading a module, the Interpreter raises an ImportError.

Indentation Error

The IndentationError is raised when there is an incorrect indentation. In Chapter 7, Example 5 demonstrates an IndentationError.

IndexError

An IndexError is raised when the index of a sequence is out of range. If the index is not an integer, TypeError is raised. The base class of an IndexError is a LookupError. See Examples 1-2 in Chapter 7.

IOError

Starting from Python 3.3, an IOError is an OSError.

KeyError

A `KeyError` is raised when a key is not found in a dictionary and is a subclass of `LookupError`. See Example 20.

KeyboardInterrupt

A `KeyboardInterrupt` is raised when the user hits the interrupt key (Ctrl+c or delete).

LookupError

A `LookupError` is the base class for `KeyError` and `IndexError`.

MemoryError

Raised when an operation runs out of memory.

ModuleNotFoundError

The `ModuleNotFoundError` error indicates a module could not be located and is a subclass of `ImportError`.

NameError

Raised when a variable is not found in the local or global scope. This exception occurs when an identifier is invalid or an unknown name. For example, a misspelled identifier can cause a `NameError`. The Spyder IDE would highlight a `NameError`. In Chapter 7, Examples 3, 10, 13, and 22 demonstrate `NameErrors`.

The Chapter 4 topic, “Variables and Objects in Memory,” outlined how the Python Interpreter creates variables and objects when you

run a program or script. If you type your object name in the Console and the Traceback says “NameError,” ensure that you ran the line of code that creates the object.

OSError

Raised when a system operation causes a system-related error, such as failing to find a local file on disk.

OverflowError

Raised when the result of an arithmetic operation is too large to be represented. The OverflowError is a subclass of ArithmeticError.

RecursionError

A RecursionError is derived from the base class RuntimeError. A RecursionError is raised when the maximum recursion depth is exceeded.

RuntimeError

Raised when an error is detected that does not fall under any other category.

StopIteration

Raised by the next() function to indicate that there is no further item to be returned by the iterator.

SyntaxError

Raised by the parser when a syntax error is encountered. The Spyder Editor makes it virtually impossible to have Syntax errors. A yellow triangle appears to the left of the line number if there is a Syntax error in the code.

TabError

Raised when indentation contains an inconsistent use of tabs and spaces. The TabError is a subclass of IndentationError.

SystemError

Raised when the interpreter detects an internal error.

SystemExit

Raised by the `sys.exit()` function.

TypeError

Raised when a function or operation is applied to an object of an incorrect type. Attempting to perform an operation on an incorrect object type.

ValueError

A ValueError is raised when a function gets an argument of correct type but improper value. For example, a datetime object considers a time value for seconds < 60 or a month between 1 and 12 to be valid. A datetime month value of 13 creates an exception, and the Python Interpreter displays a ValueError. The syntax below is invalid for a datetime object:

```
d1 = datetime( 1999, 13, 31)
```

In Chapter 7, Examples 21, 23, and 31 demonstrate a `ValueError`.

ZeroDivisionError

Raised when the second argument of a division or modulo operation is zero. The `ZeroDivisionError` is a subclass of `ArithmeticError`.

6. Try This

In this chapter we discuss

What is the Object Value?

String and Number Variable Values

Tuple Objects and Values

List Objects and Values

Dictionary Objects and Values

Does the Object Have a Value of None?

What is the Object Type?

What is the Length of the Object?

What are the Function/Method Arguments?

What is the Return Object of the Function?

The examples in the next chapter do have several suggestions on how to identify a particular bug and are great if you're experiencing the same problem. But this is the real world, and we both know that's not likely to happen. My concern with only using "Examples," is you'll rarely encounter the same issue when working with your code. Your situation is unique, and may not fit one of the examples.



To provide the missing piece of the debugging puzzle, I'm going to take some time in this Chapter to break down the debugging process into a reusable format. I'll cover some common issues. Unfortunately, my issue list isn't going to be all-inclusive, but I hope it kickstarts your debugging experience.

While an odd chapter title, "Try This," is a fitting name. When I was learning to program, I would share my dilemmas with a good friend. He would say, "Try this..." and offer a few suggestions. That little nudge in the right direction was a godsend that helped me find my way. I'm not sure if I can create that experience for you, but I'm going to try.

As we work through the next sections, you'll notice a common theme, where we look at these topics in different contexts.

- Object Values
- Types of Objects
- Length of Objects
- Passing Arguments to Functions or Methods.
- The Return Object of a Function

We'll look at the common objects outlined below. This list of objects isn't every possible Python object, but I think these are enough to get you started.

- Strings and Numbers
- Tuples
- Lists
- Dictionaries

It can be exasperating when you have a runtime or logic error and have no idea where to start debugging. The suggestions in this chapter may help you get started debugging your program.

6.1 What is the Object Value?

When I am debugging, often, the first thing I check is the object value. If you decide to take the hands-on approach and add print statements to your code or use Interactive Mode in the Console, the next few topics show you examples for strings, tuples, lists, and dictionaries. In the case of data structures like lists, tuples, and dictionaries, I'll also include the syntax to inspect all items or a single item. This content may be a bit repetitive, but on the plus side, this is a handy reference.

6.2 String and Number Variable Values

In this topic, I'll look at several ways to find the value of String and Number Variables.

Print the Value of a String Variable

Add a print statement to your script in the **Editor** window, and ► run your program.

```
mystring = "Purple Peanuts"
```

In the example the follows, I add a print statement in the Editor window. When I run the program, the output of the print statement is shown in the **Console** pane. The Console is the Python Shell.

A String Identifier: mystring

Value: purple peanuts

Reference: Chapter 4 - Add Print Statements

```
1 mystring = "purple peanuts"  
2 print(mystring)  
3
```

```
In [1]: runfile('C:/SampleScript.py',  
wdir='C:')  
purple peanuts
```



Inspect a Number Variable in Debug Mode

[Debug Mode](#) with [Variable Explorer](#) is a simple way to see object values as you step through your code. In this example, the Editor has one line to create a string variable named “mynumber.”

```
mynumber = 57
```

1. First, I run ► the program in Debug Mode.
2. Next, I type “ **mynumber** ” in the **Console** . Because I am in Debug Mode, the Console prompt is **ipdb>** .

The **Variable Explorer** also shows the value of the “ **mynumber** ” variable.

Inspect a String Value with Interactive Mode

To see the value of the string in Interactive Mode, type the string name “mystring” in the **Console** .

```
mystring = “purple peanuts”
```

A String Identifier: mystring

Value: purple peanuts

Reference: Chapter 4 - Interactive Mode

1. Run the program ► to create the variables in memory.
2. Type “mystring” in the Console.
3. The Python Interpreter displays the value of “mystring” on the next line in the **Console** .

In [2]: mystring
Out[2]: 'purple peanuts'



6.3 Tuple Objects and Values

In this topic, I'll look at several ways to inspect Tuple Objects and Tuple Item values. To create a Tuple, use this syntax in the **Editor** :

```
mytuple = ('Apple', 'Orange', 'Watermelon')
```

Print All Tuple Item Values

Add a print statement to your script in the **Editor** window and ► run your program. The output of the print statement is shown in the **Console** pane.

All Items in the Tuple

Identifier: mytuple

Value: Name: Apple, Orange, Watermelon

Reference: Chapter 4 - Add Print Statements

```
2  
3 print(mytuple)  
4
```

In [1]: runfile('C:/SampleScript.py',
wdir='C:')
('Apple', 'Orange', 'Watermelon')



Print a Tuple Item Value

To see the value of a Tuple item, type “mytuple[0] in the Console. The first item in the Tuple has an index value of 0 .

A Tuple Item

Identifier: mytuple[0]

Value: Name: Apple

Reference: Chapter 4 - Add Print Statements

1. Add a print statement to your script in the **Editor** window.
2. Run your program. The output of the print statement is shown in the **Console** pane.

```
1  
2 print(mytuple[0 ])  
3
```

In [1]: runfile('C:/SampleScript.py',
wdir='C:')
Apple



Inspect All Tuple Items in Interactive Mode

To see all the values of a tuple named “mytuple,” type “mytuple” in the **Console** .

All Items of the Tuple

Identifier: mytuple

Value: Name: Apple, Orange, Watermelon

Reference: Chapter 4 - Interactive Mode

1. Run the program to create the variables in memory.
2. Type “mytuple” in the Console in **Interactive Mode** . The Python Interpreter displays the value of “mytuple” on the next line in the **Console** .

Object Type	Identifier	Value
A Tuple	mytuple	purple peanuts

```
In [2]: mytuple
Out[2]: ('Apple', 'Orange',
'Watermelon')
```



Inspect A Tuple Item in Interactive Mode

To see the value of a tuple item “mytuple,” type “mytuple” in the **Console** . The first item in the Tuple has an index value of 0 .

A Tuple Item

Identifier: mytuple[0]

Value: Name: Apple

Reference: Chapter 4 - Interactive Mode

1. Run the program to create the variables in memory.
2. Type “mytuple[0]” in the Console in **Interactive Mode** . The Python Interpreter displays the value of the “mytuple[0]” object on the next line in the **Console** .

```
In [2]: mytuple[0 ]
Out[2]: 'Apple'
```



6.4 List Objects and Values

In this topic, I'll look at several ways to inspect List Objects and List Item values. To create a List, use this syntax:

```
mylist = ['Soda' , 'Water ' , ' Coffee']
```

Print All List Item Values

In this example, I print out all List item values to the **Console** pane.

All Items of the List

Identifier: mylist

Value: Name: Soda, Water, Coffee

Reference: Chapter 4 - Add Print Statements

1. Add a print statement to your script in the **Editor** window.
2. Run your program. The output of the print statement is shown in the **Console** pane.

```
1 mylist = ['soda', 'water',  
2 'coffee']  
3 print(mylist)
```



In **[1]**]: runfile('C:/SampleScript.py', dir='C:')
(['Soda', 'Water', 'Coffee'])



Print the Value of a List Item

To print the value of a List item, add a print statement to your script in the **Editor** window, and run your program. The second item in the List has an index value of **1** .

A List Item

Identifier: mylist[1]

Value: Soda, Water, Coffee

Reference: Chapter 4 - Add Print Statements

1. Add a print statement to your script in the **Editor** window.

2. Run your program. The output of the print statement is shown in the Console pane. In the example below, the output is “Water.”

```
1 mylist = ['soda', 'water', 'coffee'] print(mylist[1])  
2  
3
```

```
In [1]: runfile('C:/SampleScript.py', wdir='C:')  
soda
```



Inspect a List Item in Debug Mode

Debug Mode with Variable Explorer is a simple way to see object values as you step through your code. In this example, I run the program in **Debug Mode** . Because I am in Debug Mode, the prompt is **ipdb>** .

Notice the **Variable Explorer** shows the values in the “drinks” list. The third item is “coffee” and has an index value of 2 .

A List Item

Identifier: drinks[2]

Value: coffee

Reference: Chapter 4 - Debug Mode

1. Run the program in Debug Mode.
2. Type ” **drinks[2]** in the **Console** .

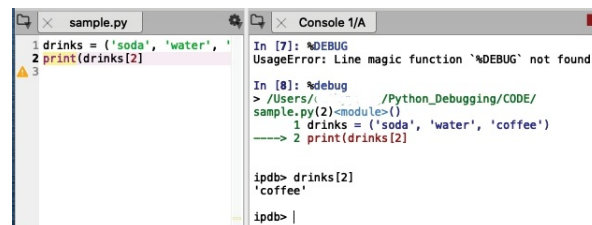


Figure
6.1

Inspect All Items of a List in the Console

To see all values of a List, type the list name in the **Console** .

All Items in the List

Identifier: mylist

Value: Name: Soda, Water, Coffee

Reference: Chapter 4 - Interactive Mode

1. Run the program.
2. Type “mylist” in the Console. The Python Interpreter displays the value of “mylist” on the next line in the **Console** .

```
In [2]: mylist  
Out[2]: ['Soda', 'Water', 'Coffee']
```



Inspect a List Item in the Console

In this example, I run the program and type “mylist[1]” in the Console. The second item in the List has an index value of **1** .

A List Item

Identifier: mylist[1]

Value: Name: Water

Reference: Chapter 4 - Interactive Mode

1. Run the program.
2. Type “mylist[1]” in the **Console** . The Python Interpreter displays the value of mylist[1] in the **Console** .

```
In [2]: mylist[1 ]  
Out[2]: Water
```



6.5 Dictionary Objects and Values

In this topic, I'll look at several ways to inspect Dictionary Objects and Dictionary Key-Pair values. To create a Dictionary, use this syntax:

```
mydictionary = { 'Name' : 'Zimmerman' ,  
                 'Grade' : 'A' ,  
                 'Course' : 'Python Programming' }
```

Print the Value of a Dictionary Key-Pair

To print the value of a Dictionary item, add a print statement to your script in the **Editor** window, and run your program.

A Dictionary Key-Pair

Identifier: mylist[1]

Value: Soda, Water, Coffee

Reference: Chapter 4 - Add Print Statements

1. Add a print statement to your script in the **Editor** window.
2. Run your program. The output of the print statement is shown in the Console pane. In the example below, the output is “Water.”

```
1 mydictionary = { 'Name' :  
2 'Zimmerman' ,  
3 'Grade' : 'A' ,  
4 'Course' : 'Python  
5 Programming' }  
print(dictionary['Name'])
```

```
In [1 ]: runfile('C:/SampleScript.py',  
wdir='C:')  
Water
```

Inspect All Dictionary Items in the Console

To see all the key-pairs of a Dictionary named “mydictionary,” type “mydictionary” in the **Console** . In this example, I run the program, and the Python Interpreter displays the value of “mydictionary” on the next line in the **Console** .

All Dictionary Items

Identifier: mydictionary

Key-Pair Values: Name: Zimmerman, Grade: A

Reference: Chapter 4 - Interactive Mode

1. Run the program.
2. Type “mydictionary” in the Console. The Python Interpreter displays the value of “mylist” on the next line in the **Console** .

```
In [2 ]: mydictionary  
Out[2 ]: 'Name': 'Zimmerman', 'Grade':
```

'A'



Inspect a Dictionary Item Value in the Console

Once you know a key name in a Dictionary, you can find the value of the Dictionary key-pair item. In this example, I run the program and type `mydictionary['grade']` in the Console. The key name is “grade.”

A Dictionary Item

Identifier: `mydictionary['Grade']`

Value: A

Reference: Chapter 4 - Interactive Mode

1. Run the program.
2. Type “`mydictionary['grade']`” in the **Console** . The Python Interpreter displays the value of “`mydictionary['Grade']`” on the next line in the **Console** .

In [2]: `mydictionary['Grade']`
Out[2]: 'A'



Inspect a Dictionary Item in Variable Explorer

Debug Mode with Variable Explorer is a simple way to see object values as you step through your code. In this example, I create a variable “schoolinfo” in a “for statement” on line 5. When I step through the “for loop” twice in Debug Mode, the “schoolinfo” variable has the value of the second key-par in “mydictionary.”

A Dictionary Item

Identifier: `mydictionary['Grade']`

Variable: schoolinfo

Value: A

Reference: Chapter 4 - Debug Mode [Variable Explorer](#)

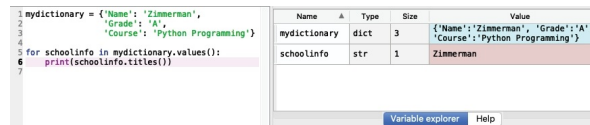


Figure 6.2 Variable Explorer

When you double click on the name of a Dictionary in Variable Explorer, a pop-up window opens

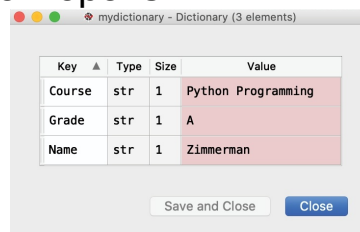


Figure 6.3 Pop-up in Variable Explorer

6.6 Does the Object have a Value of None or Whitespace?

When importing external data into Python data structures, it is not uncommon to have items with a value of “None” or unexpected whitespace. For example, if you import an Excel worksheet with empty cells, those List items have a value of “None.” Also, sometimes strings are null or equal to “”.

Functions with return values can also sometimes return “None.” The value “None” is returned when you don’t have a return value for all paths in the function, as explained in the Chapter 3 topic, [“Function Return Values”](#). Example 17 in Chapter 7 also illustrates a function that returns “None.”

The “None” value causes problems when working with functions that expect a particular type or value for an object. For example, the DateTime library function “.strptime” expects an object of type “datetime”, “time”, or “date.” If the object has a value of “None,” the Python interpreter displays an error, as shown in Chapter 7, **Example 20**.

Sadly, this is also one way Divide by Zero errors happen in a program. When you convert an item in a data structure from a string to an

“int,” an item with a value of “None” becomes a zero. The Divide by Zero error is shown in the Examples Chapter, **Example 24 and 17** , and includes a sample “if statement” to test for a “None” value.

Whitespace

Another cause of unexpected consequences is whitespace. There may be a tab, line return, or some other character that impacts a search or comparison. These functions are useful for removing those unseen characters.

lstrip() Remove left whitespace characters.

rstrip() Remove right whitespace characters.

strip() Remove whitespace characters from both sides.

6.7 What is the Object Type?

In Debug Mode, the Variable Explorer shows the type of the Object. Another option is to add a print statement or type in the Console, as outlined earlier.

```
print(type(mystring))
```

```
print(type(myfunction()))
```

Object	Syntax
number, string or data structure	type(mystring) type(mytuple) type(mylist) type(mydictionary)
a Tuple item	type(mytuple[0])
a List item	type(mylist[0])
a Dictionary item	type(mydictionary['Name'])

6.8 What is the Length of the Object?

The Len() function shows the length of the string or the number of

items in a data structure. For example, `len(mydictionary)` would return the number of Dictionary key pairs. `len(mylist)` would return the number of items in the List.

Object	Syntax
number, string or data structure	<code>len(mystring)</code> <code>len(mytuple)</code> <code>len(mylist)</code> <code>len(mydictionary)</code>
a Tuple item	<code>len(mytuple[0])</code>
a List item	<code>len(mylist[0])</code>
a Dictionary item	<code>len(mydictionary('Name'))</code>

6.9 What are the Function Arguments?

First, identify what type of [arguments](#) a [Function](#) expects. Then, check your arguments to be sure they are the correct type and value, as outlined previously. The Help pane and searching the Internet are a great way to review the definition of the function to ensure both the arguments and return objects are what you expect. In the Console, you can also use these introspection functions for more information about your object, as outlined in Chapter 4 in the topic “[Interactive Mode](#) .”

In [1]: `myfunction?`

In [2]: `dir(myfunction)`

In [3]: `help(myfunction)`

The reference for built-in functions can be found on docs.python.org . Example 26 in Chapter 7 looks at these options.

The Function Call Signature

For additional information on the “[openpyxl](#)” method “`load_workbook`,” I can look at the “call signature” for a callable object. In Python v3.x, [PEP 362](#) specifies the function signature object and lists each parameter accepted by a function. In the [Console](#) , import the module and print the signature for the object, as shown below. Chapter 7, Example 20, also illustrates this syntax from [PEP 362](#) . The [inspect](#) library can also display the [DocString](#) mentioned in the topic

“Classes” in **Chapter 3** .

```
In [3]: from inspect import signature
In [4]: print(str(signature(load_workbook)))
(filename, read_only=False, keep_vba=False, data_only=False, keep_links=True)
```

6.10 What is the Return Object of the Function?

The Interactive Mode of the Console is a great way to check what a function returns. You may want to check the value, type, or length.

```
print(myfunction())
type(myfunction())
len(myfunction())
```

The Help pane is another way to review the definition of the function, to ensure both the arguments and return object is what you expect. A function returns one object, but that object might be a tuple with several items. Example 26 in Chapter 7 looks at these options.

7. Examples

In this Chapter, we take “debugging” for a spin. These examples build on everything we’ve looked at so far. It doesn’t matter if you landed here first, or read everything to this point. Either way, I provide references to those previous topics, in case you want to take a brief sojourn to review them.

Ex	Description	Built-in Error Type	Kind
1	List index out of range	IndexError	Runtime
2	List index out of range (Example 1 continued)	IndexError	Runtime
3	Wrong Variable Name	NameError	Logic
4	Invalid Assignment	Runtime	Runtime
5	While statement not indented	IndentationError	Syntax
6	Method arguments incorrect	AttributeError	Runtime
7	Empty Block is illegal	IndentationError	Syntax
8	Parentheses not matched	SyntaxError	Syntax
9	Colon missing	SyntaxError	Syntax
10	Case sensitive	NameError	Runtime
11	Keyword missing	SyntaxError	Syntax
12	Illegal characters or keyword	SyntaxError	Syntax
13	Misspelled identifier	NameError	Runtime
14	File doesn’t exist	FileNotFoundError	Runtime
15	Adding incorrect types	TypeError	Runtime
16	Misspelled keyword	SyntaxError	Syntax
17	Value is none	TypeError	Runtime
18	Module not found	AttributeError	Runtime
19	Module not found	ModuleNotFoundError	Runtime
20	Key not in Dictionary	KeyError	Runtime
21	Argument is incorrect type	ValueError	Runtime
22	Object not found- NameError	NameError	Runtime
23	Invalid data passed to method	ValueError	Runtime
24	Calculation causes a ZeroDivision Error	ZeroDivision Error	Runtime
25	There is a mistake in a math calculation		Logic Error
26	Assigning datetime value causes ValueError	ValueError	Runtime

For each example that follows, I use a systematic approach to examine the program.

Intended Outcome : What I want the program to do is the Intended Outcome.

Actual Result : What the program did is the Actual Result.

Incorrect Code : The Incorrect Code is the actual code that is not working properly.

Debugging Experiment : The steps I use to “debug” what the program is actually doing comprise the Debugging Experiment.

How to Resolve the Issue : This section is a brief description of the change to the code to resolve the issue.

Correct Code : The Correct Code works as I intended.

References : The References list previous topics related to this example.

Ex 7.1 List Index Out of Range

Description: The list index is out of range.

Intended Outcome

There are two Lists in this program, “meals” and “fruits.” I want the program to loop through each list and print the items in order.

Actual Result

The **Console** output shows the print statement on line 6 repeats with the first item in the List.

Incorrect Code

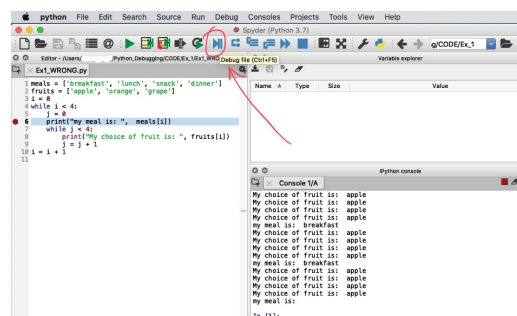
This is the Example 1 Code before any changes. Can you spot the three areas we need to fix? We'll look at each error in Examples 1-3.

```
meals = ['breakfast', 'lunch', 'snack', 'dinner']
fruits = ['apple', 'orange', 'grape']
i = 0
while i < 4:
    j = 0
    print("my meal is: ", meals[i])
    while j < 4:
        print("My choice of fruit is: ", fruits[i])
        j = j + 1
    i = i + 1
```

Debugging Experiment

In this example, when I run the program, it loops continuously. Next, I use Debug Mode to research what is happening.

1. Run the program. The program runs endlessly. The program is in an infinite loop. In the **Console**, the Python Interpreter repeatedly outputs the print statement from line 6.
2. To stop the program, in the **Consoles** menu, I select "Restart kernel." Double click twice on line 6 to add a breakpoint. Select "Debug File" on the menu, as shown below.



3. The **Console** prompt changes to **ipdb>** to indicate you are in **Debug Mode**. In the **Console**, type "s" to step through the program. The Python Interpreter moves to the next line.

Type "s" a few times, and you'll notice the program loops back to line

4. Variable Explorer shows the value of “**i**” is 0 and is not changing as the program runs.

4. In the earlier figure, the print statement on line 6 was repeatedly output to the **Console** , indicating that the “while loop” on line 4 is looping continuously. I suspect that my counter “i” is not incremented properly on line 10.

In the **Console**, pane, type “**q**” to quit **Debug Mode** . The next topic outlines the change to resolve this issue.

How to Resolve the Issue

In the **Editor** , I indent line 10. Now line 10 is part of the while loop that begins on line 4. One error is fixed, but there is another error we’ll look at in Example 2.

Good Code

```
meals = ['breakfast', 'lunch', 'snack', 'dinner']
fruits = ['apple', 'orange', 'grape']
i = 0
while i < 4:
    j = 0
    print("my meal is: ", meals[i])
    while j < 4:
        print("My choice of fruit is: ", fruits[j])
        j = j + 1
    i = i + 1
```

Reference

These topics from previous chapters are a good reference for this example.

- Chapter 4 - [Add Print Statements](#)
- Chapter 4 - [Interactive Mode](#)
- Chapter 4 - Debug Mode [Variable Explorer](#)
- Chapter 4 - [Infinite Loop](#)
- Chapter 5 - [Traceback](#)
- Chapter 5 - [IndentationError](#)
- Chapter 5 - [IndexError](#)
- Chapter 6 - Check [Object Type](#)

Ex 7.2 Index Error

Description: The list index out of range. This kind of runtime error appears when you run the program.

Intended Outcome

There are two Lists in this program, "meals" and "fruits." I want the program to loop through each list and print the items.

Actual Result

The print statement on line 8 **fruits[i]** causes an IndexError.

Incorrect Code

Example 2 code before any changes follows.

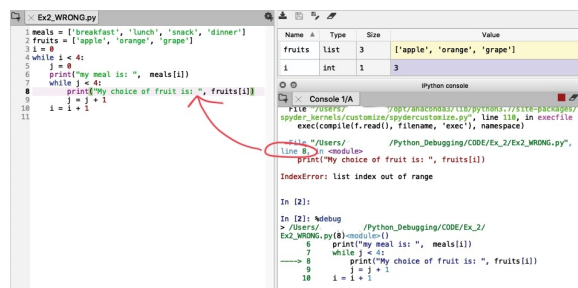
```
meals = ['breakfast', 'lunch', 'snack', 'dinner']
1 ]
2 fruits = ['apple', 'orange', 'grape']
3 i = 0
4 while i < 4:
5     j = 0
6     print("my meal is: ", meals[i])
7     while j < 4:
8         print("My choice of fruit is: ", fruits[i])
9         j = j + 1
10    i = i + 1
```

Debugging Steps

In this Example the program halts. I use Debug Mode to research what is happening.

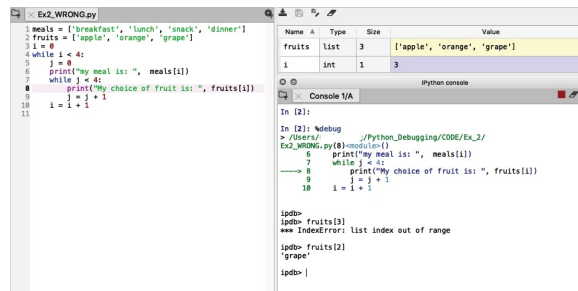
1. Run the program. The Python Interpreter halts because of an exception and displays an **IndexError** in the **Console**.

In the **Console**, the Python Interpreter displays a Traceback message telling me the error is in Line 8. If I click on "line 8" in the **Console**, it is a hyperlink to that location in my code in the Editor pane.



2. Type **%debug** In the **Console**, pane to start Debug Mode. The **Console** prompt changes to **ipdb>**.
3. Type **fruits[3]** In the **Console**, pane. The Variable Explorer shows **j** has a value of 3, so **fruits[i]** evaluates to **fruits[3]**. The message

“IndexError: list index out of range” is displayed.



4. Now type **fruits[2]** In the **Console**, pane. The value ‘grape’ is displayed. Grape is the last item in the “fruits” list. The range of the fruits list is 0 to 2.

If this had been a long list, I could have typed **len(fruits)** In the **Console** to see how many items were in the list.

In the Console, pane, type “**q**” to quit Debug Mode. The next topic outlines the change to resolve this issue.

How to Resolve the Issue

In the **Editor** , I update line 7.

while j < 3:

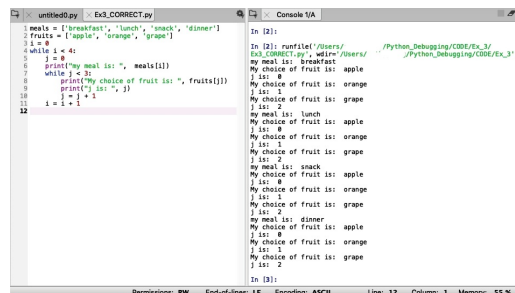


Figure 7.1 Corrected Code

Good Code

```
1 meals = ['breakfast', 'lunch', 'snack', 'dinner']
2 ]
3 fruits = ['apple', 'orange', 'grape']
4 i = 0
5 while i < 4:
6     j = 0
7     print("my meal is: ", meals[i])
8     while j < 3:
9         print("My choice of fruit is: ", fruits[j])
10        j = j + 1
        i = i + 1
```

Reference

These topics from previous chapters are a good reference for this example.

Chapter 4 - [Debug Mode](#)

Chapter 4 - [Interactive Mode](#)

Chapter 4 - Debug Mode [Variable Explorer](#)

Chapter 5 - [Traceback](#)

Chapter 5 - [IndexError](#)

Chapter 6 - Check [Object Type](#)

Chapter 6 - Check [Length of Object](#)

Ex 7.3 Wrong Variable

Description: The code references the wrong variable name.

In this example, there is a flaw in the overall design or logic of my program. The program does what I coded, but the outcome is not what I intended. In the Console, my print statement does not iterate through my list of fruits.

Intended Outcome

The program should print a list of fruits for each meal.

Actual Result

The program halts with an `IndexError` exception.

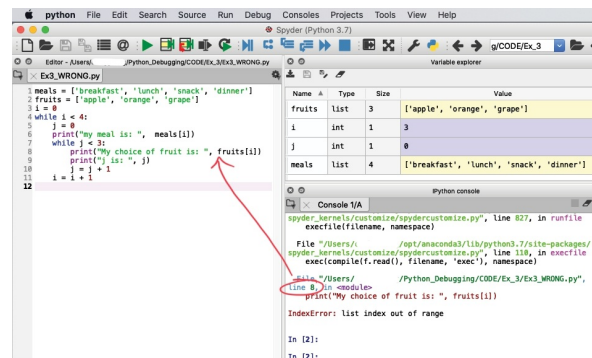
Incorrect Code

Example 3 code before any changes follows.

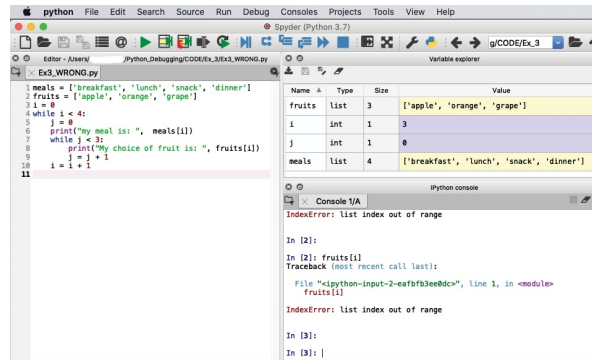
```
meals = ['breakfast', 'lunch', 'snack', 'dinner']
fruits = ['apple', 'orange', 'grape']
i = 0
while i < 4:
    j = 0
    print("my meal is: ", meals[i])
    while j < 3:
        print("My choice of fruit is: ", fruits[i])
        print("j is: ", j)
        j = j + 1
    i = i + 1
```

Debugging Steps

1. When I run the program, the Python Interpreter halts with an error. The Traceback shows the IndexError was caused by line 8.



2. In the **Console** , I type **fruits[i]** , which returns the same IndexError. Variable Explorer shows “ **i** ” has a value of 3. The **fruits** list has three items, and the indices are 0-2. Now I realize I should have used the “ **j** ” variable as a counter for the **fruits** list.



At this point, I just typed a statement in the **Console** , so I don't need to exit **Debug Mode** . Instead, I'll update my script in the **Editor** pane to resolve the issue.

How to Resolve the Issue

In the print statement I change the variable to “j.”

print (“My choice of fruit is:” , fruits[j])

Good Code

```
meals = ['breakfast', 'lunch', 'snack', 'dinner']
fruits = ['apple', 'orange', 'grape']
i = 0
while i < 4:
    j = 0
    print("my meal is: ", meals[i])
    while j < 3:
        print("My choice of fruit is: ", fruits[j])
        print("j is: ", j)
        j = j + 1
    i = i + 1
```

Reference

These topics from previous chapters are a good reference for this example.

Chapter 3 - [IndentationError](#)

Chapter 4 - [Debug Mode](#)

Chapter 4 - Debug Mode [Variable Explorer](#)

Chapter 6 - Check [Object Type](#)

Ex 7.4 Invalid Assignment

Description: The assignment statement is invalid. This kind of runtime error is uncovered when you run the program.

Intended Outcome

Print "mylist" items to the Console.

Actual Result

The **Console** output shows the print statement on line 4 repeats with

the first item in the List.

Incorrect Code

This is the Example 4 code before any changes.

```
mylist = ['soda', 'water', 'coffee']  
i = 0  
while i < 3:  
    print(mylist[i])  
    i =+ 1
```

Debugging Steps

1. Run the program. The program runs endlessly. The program is caught in an infinite loop. In the **Console**, the Python Interpreter repeatedly outputs the print statement from line 4.
2. To stop the program, in the **Consoles** menu, I select "Restart kernel." Double click twice on line 4 to add a breakpoint. Select "Debug File" on the menu, as shown below.
3. The **Console** prompt changes to **ipdb>** to indicate you are in **Debug Mode**. In the **Console**, type "**s**" to step through the program. The Python Interpreter moves to the next line.
Type "**s**" a few times, and you'll notice the program loops back to line 3. Variable Explorer shows the value of "**i**" is 0 and is not changing as the program runs.

How to Resolve the Issue

The counter is not incremented on line 5 because I reversed the syntax. The statements "**i = i + 1**" and "**i += 1**" both increment the "**i**" counter.

Good Code

```
mylist = ['soda', 'water', 'coffee']  
i = 0  
while i < 3:  
    print(mylist[i])  
    i += 1
```

Reference

These topics from previous chapters are a good reference for this example.

Chapter 4 - [Debug Mode](#)

Chapter 4 - Debug Mode - [Variable Explorer](#)

Chapter 4 - [Infinite Loop](#)

Ex 7.5 While Indentation Error

Description: The “while” statement is not indented properly. The **Console** displays an **IndentationError** .

Intended Outcome

Print a list of numbers.

Actual Result

When I run the program, it halts with an IndentationError.

Incorrect Code

This is the Example 5 code before any changes.

```
wadofcash = [111, 222, 333, 444 ]
i = 0
x = 3
while i <= x:
print(wadofcash[i])
    i = i + 1
```

Debugging Steps

Spyder displays a yellow warning triangle next to the print statement on line 6. When I hover my mouse over the triangle, a pop-up message is displayed, as shown below.

If I run the program, the **Console** displays an **IndentationError** .

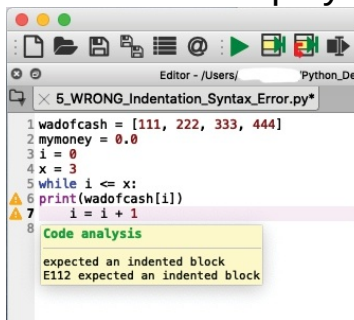


Figure 7.2 Indentation Warning

How to Resolve the Issue

Indent the print statement on line 6.

Good Code

```
wadofcash = [111, 222, 333, 444 ]  
i = 0  
x = 3  
while i <= x:  
    print(wadofcash[i])  
    i = i + 1
```

Reference

These topics from previous chapters are a good reference for this example.

Chapter 4 - [Help\(\)](#)

Chapter 5 - [Traceback](#)

Chapter 5 - [IndentationError](#)

Ex 7.6 Incorrect Method Arguments

Description: The openpyxl “cell” method has incorrect attributes. The **Console** displays an **AttributeError** .

Intended Outcome

My intention was for the code to open an Excel file and print each column 2 value as the program iterates through the rows.

Actual Result

The program halted with an “AttributeError” exception when run with the Python 2.7 Interpreter. The program runs fine on my Python 3 environment. This **AttributeError** indicates the Python Interpreter doesn’t

recognize the line 8 syntax.

Line 8 is calling a method in a class. In the discussion of Classes in Chapter 3, we created an instance of a class. Valid attribute names of a class include both “**data attributes** ” and “**methods** .” Python objects have attributes that are referenced with the dot notation.

Incorrect Code

This is the Example 6 code before any changes.

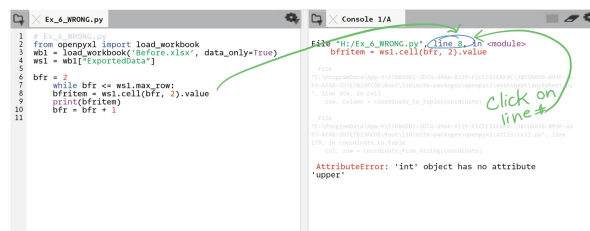
```
from openpyxl import load_workbook
wb1 = load_workbook('Before.xlsx', data_only=True)
ws1 = wb1["ExportedData"]
bfr = 2
while bfr <= ws1.max_row:
    bfritem = ws1.cell(bfr, 2).value
    print(bfritem)
    bfr = bfr + 1
```

Debugging Experiment

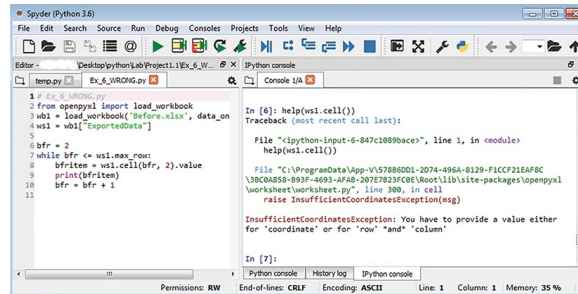
In this example, when I run the program, the Python Interpreter prints an “AttributeError” to the Console. I use Help to research what is happening.

1. Run the program. The Python Interpreter halts because of an exception and displays an **AttributeError** in the **Console**.

In the **Console**, the Python Interpreter displays a Traceback message telling me the error is in Line 8. If I click on “line 8” in the **Console**, it is a hyperlink to that location in my code **Ex_6_WRONG.py** in the Editor pane.



2. The issue seems related to the object on line 8, and I suspect there is something wrong with the syntax for the object value. I'm curious about what syntax I should use with the cell method. In the **Console**, type **help(ws1.cell())** or **dir(ws1.cell())** for more information on the object.



3. Help indicates the Python Interpreter could not use the values for row and column when calling the function “[cell](#).” In line 8, I need to add the argument keywords (or names).

In the Console pane, type “**q**” to quit Debug Mode. The next topic outlines the change to resolve this issue.

How to Resolve the Issue

In the Editor pane, update line 8 of **Ex_6_WRONG.py** to use the keywords, as shown below. This change ensures the program runs with Python 2.7 or 3.7.

```
bfritem = ws1.cell(row=bfr, column=2 ).value
```

Good Code

```
from openpyxl import load_workbook
bfritem = ws1.cell(row=bfr, column=2 ).value
wb1 = load_workbook('Before.xlsx', data_only=True)
ws1 = wb1["ExportedData"]
bfr = 2
while bfr <= ws1.max_row:
    bfritem = ws1.cell(row=bfr, column=2 ).value
    print(bfritem)
    bfr = bfr + 1
```

Reference

These topics from previous chapters are a good reference for this example.

- Chapter 3 - [Attributes](#)
- Chapter 3 - [Methods](#)
- Chapter 4 - [Help\(\)](#)
- Chapter 4 - [Interactive Mode](#)
- Chapter 5 - [Traceback](#)
- Chapter 5 - [AttributeError](#)
- Chapter 6 - Check [Arguments](#)

Ex 7.7 Empty Block of Code

Description : An empty block of code is illegal. The **Console** displays an **IndentationError** .

Intended Outcome

While writing a program, I want to have a block of code that does nothing. At some point, I intend to add logic.

Actual Result

The Python Interpreter has an `IndentationError` exception.

Incorrect Code

This is the Example 7 code before any changes.

```
for mynum in [157, 19, 56 ]:  
    if mynum == 157 :  
    else:  
        print('Happy birthday, you are', mynum)
```

Debugging Steps

The **Console** shows an **IndentationError** on line 3. As is often the case, the actual error is the line above.

How to Resolve the Issue

In keeping with my design goal, I want the code to do nothing, so I add a `pass()` statement.

Good Code

```
for mynum in [157, 19, 56 ]:  
    if mynum == 157 :  
        pass  
    else:  
        print('Happy birthday, you are', mynum)
```

Reference

These topics from previous chapters are a good reference for this example.

Chapter 4 - [Help\(\)](#)

Chapter 5 - [Traceback](#)

Chapter 5 - [RuntimeError](#)

Chapter 5 - [SyntaxError](#)

Ex 7.8 Parentheses Not Matched

Description: Parentheses not matched. The **Console** displays a **SyntaxError** .

Intended Outcome

On line 3, I want to calculate projected sales.

Actual Result

When I run the program, the **Console** displays a Syntaxerror in line 3.

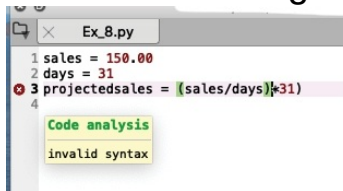
Incorrect Code

This is the Example 8 code before any changes.

```
sales = 150.00
days = 31
projectedsales = (sales/days)*31 )
```

Debugging Steps

The **Editor** displays a red x to the right of line 3, indicating the parser identified invalid syntax. When I hover my mouse over the parentheses on that line, the paired parentheses are highlighted in green.



When I move my mouse to the end of the line, the last parenthesis is highlighted in orange, indicating there is no corresponding parenthesis.

How to Resolve the Issue

In line 3, I added an open parenthesis in front of “sales” as shown below.

Good Code

```
sales = 150.00
days = 31
projectedsales = ((sales/days)*31 )
```

Reference

These topics from previous chapters are a good reference for this example.

Chapter 4 - [Help\(\)](#)

Chapter 5 - [SyntaxError](#)

Ex 7.9 Missing Colon

Description: The colon is missing. The **Console** displays a **SyntaxError** .

Intended Outcome

Print mylist items to the Console.

Actual Result

When I run the program, there is a SyntaxError.

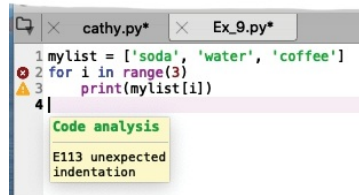
Incorrect Code

This is the Example 9 code before any changes.

```
mylist = ['soda', 'water', 'coffee']
for i in range(3)
    print(mylist[i])
```

Debugging Steps

The Editor has a **red x** by line 32 and a **yellow triangle** to the left of line 3. When I hover over the yellow triangle, a pop-up message is displayed, “unexpected indentation.”



How to Resolve the Issue

Line 2 is a “for” statement. I added a colon at the end of the line.

Good Code

```
mylist = ['soda', 'water', 'coffee']  
for i in range(3):  
    print(mylist[i])
```

Reference

These topics from previous chapters are a good reference for this example.

Chapter 4 - [Help\(\)](#)

Chapter 5 - [SyntaxError](#)

Ex 7.10 Case Sensitive

Description: Python is case sensitive. Variables with the wrong case are interpreted as misspelled by the Python Interpreter and cause a `NameError`.

Intended Outcome

Print mylist items to the Console.

Actual Result

When I run the program, the Console displays a `NameError`.

Incorrect Code

In this example, I changed the case on the variable “myList” with the intention of causing a `NameError`.

If you previously ran Example 9, “mylist” is still in memory, and you won’t see a `NameError`. I wanted to demonstrate that sometimes you need to reset the “namespace” to be certain you’re looking at values from this program.

This is the Example 10 code before any changes.

```
myList = ['soda', 'water', 'coffee']  
for i in range(3):  
    print(mylist[i])
```

Debugging Steps

1. To clear memory (the namespace), in the **Consoles** menu, select “Restart kernel.” You could also type `%reset` in the Console.
2. When I run the program, the **Console** displays a **NameError** on line 3

How to Resolve the Issue

On the first line, I change “mylist” to all lowercase.

Good Code

```
mylist = ['soda', 'water', 'coffee']  
for i in range(3):  
    print(mylist[i])
```

Reference

These topics from previous chapters are a good reference for this example.

Chapter 4 - [Help\(\)](#)

Chapter 5 - [NameError](#)

Ex 7.11 Missing Keyword

Description : A keyword missing when defining a function causing a SyntaxError.

Intended Outcome

This code creates a new function that adds two numbers together.

Actual Result

The Editor displays a red “x” to the left of line 1. When I run the program, the Console Traceback says there is a SyntaxError on line 1.

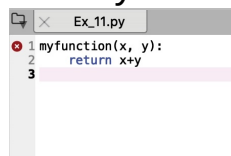


Figure 7.3 Function with Error

Incorrect Code

This is the Example 11 code before any changes.

```
myfunction(x, y):  
    return x+y
```

Debugging Steps

When looking at line 1, I see that I left off the keyword “def.” I could also search online for the Python documentation on defining a function.

How to Resolve the Issue

Add “**def** ” to the beginning of line 1.

Good Code

```
def myfunction(x, y):  
    return x+y
```

Reference

These topics from previous chapters are a good reference for this example.

Chapter 5 - [Traceback](#)

Chapter 5 - [SyntaxError](#)

Ex 7.12 Illegal Character

Description: Illegal character in identifier name causes a `SyntaxError`.

Intended Outcome

This code creates a string variable.

Actual Result

The program halts with a `SyntaxError`.

Incorrect Code

This is the Example 12 code before any changes.

```
my$str = 'hello'  
print(my$str)
```

Debugging Steps

The Editor has a red “x” to the left of line 1, indicating there is a syntax error in my assignment statement. Normally, the Editor highlights functions and methods in purple, and variables are black. The formatting is different because the Editor is unable to interpret the code.

When I run the program, the Console displays an arrow pointing to the invalid character in my string name.

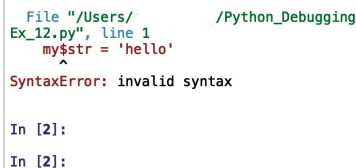
A screenshot of a code editor and its console output. The code editor shows a file named 'Ex_12.py' at line 1 with the code 'my\$str = 'hello''. A red 'x' is placed to the left of the first line, and a small arrow points to the '\$' character in the variable name 'my\$str'. The console below shows the error message 'SyntaxError: invalid syntax' and two prompts 'In [2]:'.

Figure 7.4 Invalid Character in the Console

How to Resolve the Issue

Special characters like \$, #, and @ are not allowed for variable names. I rename my variable to “mystr” and the SyntaxError is resolved.

Good Code

```
mystr = 'hello'  
print(mystr)
```

Reference

These topics from previous chapters are a good reference for this example.

Chapter 4 - [Help\(\)](#)

Chapter 4 - [Debug Mode](#)

Chapter 4 - [Interactive Mode](#)

Chapter 5 - [NameError](#)

Chapter 5 - [SyntaxError](#)

Ex 7.13 Undefined Name

Description : Undefined name when variable is misspelled. Traceback shows a NameError.

Intended Outcome

Line two calculates profit using the “royalties” variable.

Actual Result

The Editor has a yellow triangle to the left of line 2. When I run the program the Traceback shows a NameError.

Incorrect Code

This is the Example 13 code before any changes.

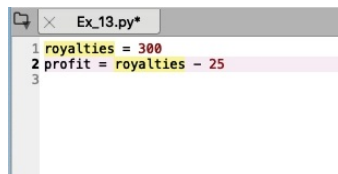
```
royalties = 30  
profit = royaltie - 2
```

Debugging Steps

In the Editor, if I click on the variable name, the Editor highlights all instances of the variable throughout the code. I assign 300 to the “royalties” variable in line 1. The variable name is misspelled on line 2.

How to Resolve the Issue

On line 2 I correct the variable name. The Editor pane highlights all instances of the variable name in yellow, so I know I am using the variable I intended on line 2.



Good Code

```
royalties = 30  
profit = royalties - 2
```

Reference

These topics from previous chapters are a good reference for this example.

Chapter 5 - [Traceback](#)

Chapter 5 - [NameError](#)

Ex 7.14 FileNotFoundError

Description: While reading a file, the Console halted with an error “FileNotFoundError.” In this example, factors outside your control impact your program.

Intended Outcome

This program opens a text file and prints the contents in the Console.

Actual Result

The Console displays a “FileNotFoundError.”

Incorrect Code

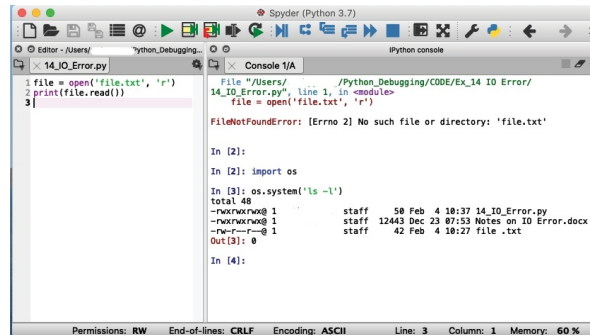
This is the Example 14 code before any changes.

```
file = open('file.txt', 'r')  
print(file.read())
```

Debugging Steps

The “FileNotFoundError” has a base class of “IOError.” I want to check the filename in my OS directory.

1. Import the “os” library to work with the OS commands. In the Console, type “import os” and then type the list command, as shown below.



The screenshot shows the Spyder Python IDE interface. On the left, the editor window displays a file named `14_IO_Error.py` with the following code:

```
1 file = open('file.txt', 'r')
2 print(file.read())
3
```

On the right, the IPython console shows the execution of the code. It first displays a `FileNotFoundError` message: `FileNotFoundError: [Errno 2] No such file or directory: 'file.txt'`. Then, the user enters `In [2]: import os`. Next, the user enters `In [3]: os.system('ls -l')`, which outputs a directory listing:

```
total 48
-rwxrwxrwx@ 1 staff 50 Feb  4 10:37 14_IO_Error.py
-rwxrwxrwx@ 1 staff 12443 Dec 23 07:53 Notes on IO Error.docx
-rwxrwxrwx@ 1 staff 42 Feb  4 10:27 file .txt
Out[3]: 0
```

At the bottom of the console, the status bar shows: `Permissions: RW End-of-lines: CRLF Encoding: ASCII Line: 3 Column: 1 Memory: 60 %`.

2. Type `os.system('ls -l')` to see a list of files in the current directory. The filename has a space in the name. I can rename the file or updated my program.

How to Resolve the Issue

I decided to rename the file. I did not need to change my code. I can also add “try” and “except” logic to handle this type of error.

Good Code

```
file = open('file.txt', 'r')  
print(file.read())
```

Reference

These topics from previous chapters are a good reference for this example.

Chapter 4 - [Interactive Mode](#)

Chapter 5 - [Traceback](#)

Chapter 5 - [RuntimeError](#)

Chapter 5 - [OSError \(IOError\)](#)

Ex 7.15 Error Adding Numbers

Description: TypeError when adding numbers.

Intended Outcome

Print the total when adding two numbers.

Actual Result

When I run the program, the Console Traceback message is a TypeError. The code uses “try” and “except” to provide exception details in the Traceback message. In this example, the code prints a custom message when there is a TypeError. The last line prints a custom message if there is another type of Exception.

Incorrect Code

This is the Example 15 code before any changes.

```
eur = 'euro'
gbp = 8
usd = 3.45
try :
    mymoney = eur + usd
    print(mymoney)
except TypeError:
    print("Type error when adding")
except Exception as strmsg:
    print(strmsg)
```

Debugging Steps

Add the variable information to my print statement and run the program again.

```
print("Type error when adding; eur", eur, "; usd", usd)
```

The Console Traceback shows the variable values. After reviewing I realize I used “eur” which is a string, and I meant to use “gbp.”

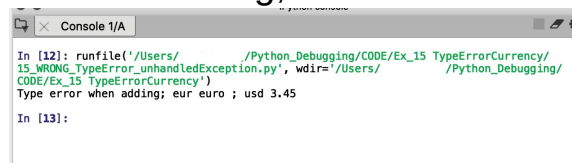


Figure 7.5 Console Exception Message

Note: I could also have used the “**type()**” function to identify the type of variables.

How to Resolve the Issue

The line assigning a value to “mymoney” is updated to use **gbp + usd** .

Good Code

```
eur = 'euro'
gbp = 8
usd = 3.45
try :
    mymoney = gbp + usd
    print(mymoney)
except TypeError:
    print('Type error when adding; gbp', gbp, ' ; usd', usd)
except Exception as strmsg:
    print(strmsg)
```

Reference

These topics from previous chapters are a good reference for this example.

Chapter 4 - [Print Statements](#)

Chapter 4 - [Type\(\)](#)

Chapter 5 - [Traceback](#)

Chapter 5 - [TypeError](#)

Ex 7.16 Misspelled Keyword

Description: A misspelled keyword causes a SyntaxError. This is similar to Example 13 where a variable name was misspelled causing a NameError.

Intended Outcome

An if-else statement prints a message to the Console.

Actual Result

The Editor has a red “x” next to line 4. When I run the program it

halts with a “SyntaxError.”

Incorrect Code

This is the Example 16 code before any changes.

```
if 4 < 5:  
    pass  
esle:  
    print(“Python rocks”)
```

Debugging Steps

There is a typographical error on line3.

How to Resolve the Issue

Update line 3 with the correct spelling of the keyword.

Good Code

```
if 4 < 5:  
    pass  
else:  
    print("Python rocks")
```

Reference

These topics from previous chapters are a good reference for this example.

Chapter 4 - [Help\(\)](#)

Chapter 5 - [Traceback](#)

Chapter 5 - [NameError](#)

Chapter 5 - [SyntaxError](#)

Ex 7.17 Value is None

Description: The function return value is "None".

Intended Outcome

My calculation using the "mymath" function **return value** prints the result to the Console.

Actual Result

When "i" is 3, the Traceback In the **Console** , displays a **TypeError** .

Incorrect Code

This is the Example 17 code before any changes.

```
def mymath (i=5 , j=200 ):
    if i > 3 :
        return i*j
    if i < 3 :
        return j/i
result = mymath(3 , 100 )
print(result/10 )
```

Debugging Steps

This program works as expected when “i” is any number except 3.

1. To identify what type the function returns, I use the `type()` function in the Console.

```
In[2] : type(mymath(3,100 ))
Out[2]: NoneType
```

The function returns “None” when “i” is 3.

2. In the Console, I call the “mymath” function again where “i” is 4. Now the type is “int.” This means that there is a path through the “mymath” function without a return value.

In Chapter 3, we looked at a [function that did not have a return value for all paths](#). For this example, I’m not going to change the “mymath” function. Instead, I add logic to my program to handle a “None” value.

How to Resolve the Issue

Add an “if” statement to test for a “None” value.

Good Code

```
def mymath (i=5 , j=200 ):
    if i > 3 :
        return i*j
    if i < 3 :
        return j/i
    if i == 3 :
        return None
result = mymath(3 , 100 )
print(result/10 )
```

```
if i > 3 :  
    return i*j  
if i < 3 :  
    return j/i  
result = mymath(3 , 100 )  
if result is not None:  
    print(result/10 )  
else :  
    print("result is None" )
```

Reference

These topics from previous chapters are a good reference for this example.

Chapter 3 - [Function Returns None](#)

Chapter 4 - [Interactive Mode](#)

Chapter 5 - [Traceback](#)

Chapter 6 - Check [Object Type](#)

Chapter 6 - Value is [None](#)

Ex 7.18 Method Not Found

Description: AttributeError when the method is not found.

Intended Outcome

Using the math library, I would like to use a cube method.

Actual Result

When I run the code the Console displays the message "AttributeError :module 'math' has no attribute 'cube'."

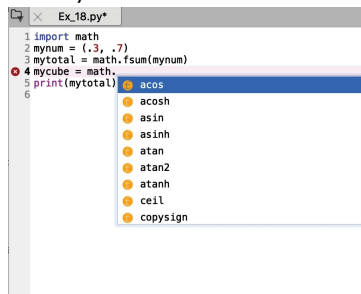
Incorrect Code

This is the Example 19 code before any changes.

```
import math
mynum = (.3 , .7 )
mytotal = math.fsum(mynum)
mycube = math.cube(3 )
print(mytotal)
```

Debugging Steps

I need to see what functions or methods are available for the math library. In the Editor, after I type “math.” I pause for a moment. A pop-up opens with available methods, as shown below.



In the Console, I could also type dir(math) to see a list of functions/methods in the math library.

How to Resolve the Issue

After scanning the list I see there is no “cube” method available. I update the code to manually calculate the cube of “3.”

Good Code

```
import math
mynum = (.3 , .7 )
mytotal = math.fsum(mynum)
mycube = 3 *3 *3
print(mytotal)
```

Reference

These topics from previous chapters are a good reference for this example.

Chapter 4 - `Help()`

Chapter 3 - [Tuple](#)

Chapter 4 - Debug Mode

Chapter 4 - Interactive Mode

Chapter 5 - [Traceback](#)

Chapter 5 - [NameError](#)

Ex 7.19 Module Not Found

Description: `ModuleNotFoundError` when when the method is not found.

Intended Outcome

Using the “matplotlib” library I want to plot a chart.

Actual Result

When I run the code, the [Console](#) displays `ModuleNotFoundError`.

Incorrect Code

This is the Example 19 code before any changes.

```
import matplotlib.pyplot as plt
plt.plot([1 , 2 , 3 , 4 ], [25 , 30 , 29 , 31 ])
plt.ylabel('age')
plt.xlabel('participants')
plt.show()
```

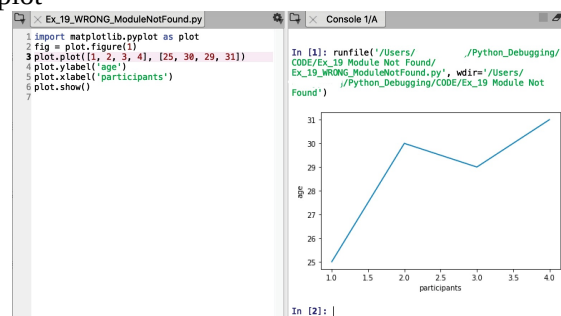
Debugging Steps

I am trying to use the library “matplotlib” plot function, but am unsure

how to import the library. When I search the Internet for “import matplotlib” I find the correct syntax. In the help pane, I could search for “matplotlib.pyplot” for additional details.

How to Resolve the Issue

The first line needs updated to import the correct module. There is a missing period. After I run the updated program, In the Console, I can type **help(plot.figure(1))** to see additional information on my new object.
`import matplotlib.pyplot as plot`



Good Code

```
import matplotlib.pyplot as plot
plot.plot([1, 2, 3, 4 ], [25, 30, 29, 31 ])
plot.ylabel('age')
plot.xlabel('participants')
plot.show()
```

Reference

These topics from previous chapters are a good reference for this example.

Chapter 4 - [Help\(\)](#)

Chapter 5 - [Traceback](#)

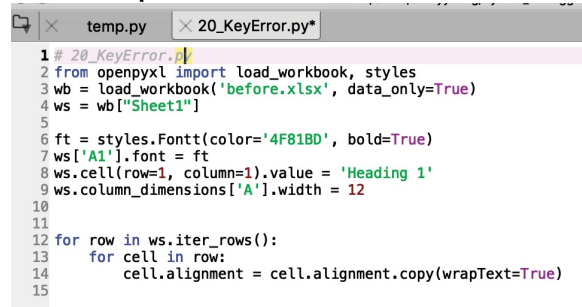
Chapter 5 - [ModuleNotFound](#)

Ex 7.20 Key Not in Dictionary

Description: Keyerror. The Key is not in the “wb ” Dictionary.

Intended Outcome

This program works with an Excel file and formats cells. Line 11 loops through the rows, and line 12 loops through the cells of each row. In line 13 I want to set “wrap text” for the cells.

A screenshot of a code editor with two tabs: 'temp.py' and '20_KeyError.py*'. The '20_KeyError.py' tab is active and shows a Python script. The script imports 'load_workbook' and 'styles' from 'openpyxl', loads a workbook named 'before.xlsx', and attempts to access 'wb["Sheet1"]'. It then sets a font for cell 'A1' and sets the value of cell 'A1' to 'Heading 1'. Finally, it sets the column width of column 'A' to 12. The script then enters a nested loop to iterate over rows and cells, attempting to set the wrapText property of each cell's alignment. The script is as follows:

```
1 # 20_KeyError.py
2 from openpyxl import load_workbook, styles
3 wb = load_workbook('before.xlsx', data_only=True)
4 ws = wb["Sheet1"]
5
6 ft = styles.Font(color='4F81BD', bold=True)
7 ws['A1'].font = ft
8 ws.cell(row=1, column=1).value = 'Heading 1'
9 ws.column_dimensions['A'].width = 12
10
11
12 for row in ws.iter_rows():
13     for cell in row:
14         cell.alignment = cell.alignment.copy(wrapText=True)
15
```

Figure 7.6 20_KeyError.py Script

Actual Result

The program halts and the **Traceback** In the **Console**, displays this error:

KeyError: 'Worksheet Sheet1 does not exist.'

Incorrect Code

This is the Example 20 code before any changes.

```
# 20_KeyError.py
from openpyxl import load_workbook, styles
wb = load_workbook('before.xlsx', data_only=True)
ws = wb["Sheet1"]
ft = styles.Fontt(color='4F81BD', bold=True)
ws['A1'].font = ft
ws.cell(row=1, column=1).value = 'Heading 1'
ws.column_dimensions['A'].width = 12
for row in ws.iter_rows():
    for cell in row:
        print("Looping through data")
```

Debugging Experiment

In this Example, when I run the program the program halts. I use Debug Mode to research what is happening.

1. Run the program. The Python Interpreter halts because of an exception.
2. In the **Console** , pane the **Traceback** displays an error, as shown below.

KeyError: 'Worksheet Sheet1 does not exist.'

3. Type **%debug** In the **Console**, pane to start Debug Mode. The **Console** prompt changes to **ipdb>** .
4. While in Debug Mode, In the **Console** , type “ **u** ” to step backward through the program. The Python Interpreter moves back to the previous call. Now an arrow indicates the last line of code was **line 4** in my 20_KeyError.py script.

```

ipdb> u
> /20_KeyError.py (4)<module> ()
    2 from openpyxl import load_workbook, styles
    3 wb = load_workbook('before.xlsx', data_only=True)
----> 4 ws = wb["Sheet1"]
    5
    6 ft = styles.Fontt(color='4F81BD', bold=True)

```

Line 4 is trying to reference “Sheet1.” Although it’s not readily apparent, this **KeyError** indicates this is a Dictionary key. In the Console, pane, type “**q**” to quit Debug Mode.

5. Now I need a method to find the **sheetnames** for the “**wb**” object. In the **Console**, I use the help command, as shown below.

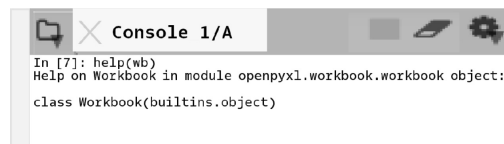


Figure 7.7 Help In the Console, Pane

When I scroll down In the **Console**, pane I see the methods for the “**wb**” object. A small sample of the output is shown below. I am interested in the “sheetnames” method.

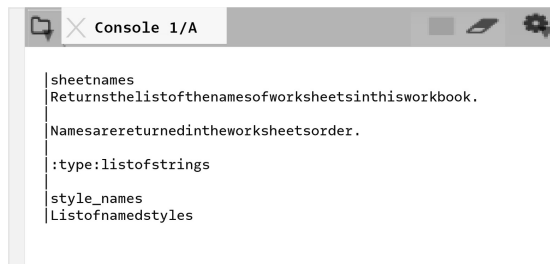


Figure 7.8 Details on “wb” Object Methods and Functions

To see the sheetnames for the “**wb**” object type “**ws.sheetnames**” In the **Console**, pane, as shown below.

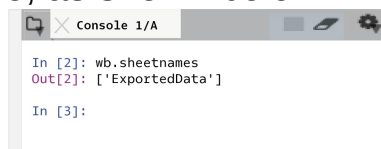


Figure 7.9 The sheetnames Method

The output indicates there is only one worksheet named “**ExportedData**”.

How to Resolve the Issue

When you create a Dictionary named “mydictionary,” it’s easier to recognize a Dictionary KeyError. Because the openpyxl created the “**ws**” object it’s not as obvious that this was a Dictionary KeyError. Tuples are immutable, and any immutable object can be used as a Dictionary key. For additional information, search the Intranet for help on openpyxl worksheet objects.

To resolve the error, I update my code to the correct worksheet name, as shown below.

Good Code

In the Editor, I updated line 4 with the sheetname “ExportedData,” as shown below.

```
# 20_CORRECT_KeyError.py
from openpyxl import load_workbook, styles
wb = load_workbook('before.xlsx', data_only=True)
ws = wb["ExportedData"]
ft = styles.Fontt(color='4F81BD', bold=True)
ws['A1'].font = ft
ws.cell(row=1, column=1).value = 'Heading 1'
ws.column_dimensions['A'].width = 12
for row in ws.iter_rows():
    for cell in row:
        print("Looping through data")
```

Additional Troubleshooting

In step 4, I wanted more information on “**load_workbook** .” The signature function from the Chapter 6 topic, “The [Function Call Signature](#)” would be perfect for this purpose. With Python v3.x the “signature” lists each parameter accepted by a function. In the Console, import the module and print the signature for the object, as shown below.

```
In [3]: from inspect import signature
In [4]: print(str(signature(load_workbook)))
(filename, read_only=False, keep_vba=False, data_only=False, keep_links=True)
```

Reference

These topics from previous chapters are a good reference for this example.

- Chapter 3 - [Dictionary](#)
- Chapter 3 - [Tuple](#)
- Chapter 4 - Debug Mode
- Chapter 4 - Help()
- Chapter 5 - [Traceback](#)
- Chapter 5 - [KeyError](#)

Ex 7.21 Incorrect Argument Type

Description: A function argument is an incorrect type causing a ValueError.

Intended Outcome

The program asks for a month as input. The `int()` function converts the data to an integer so I can use it in a calculation. The `print()` function outputs the value to the [Console](#).

Actual Result

When the program runs, if I enter a string for input, a ValueError is displayed in the [Console](#). A ValueError is raised when a function gets an argument of correct type but improper value.

Incorrect Code

This is the Example 21 code before any changes.

```
birthmo = int(input('what month were you born?'))
monthstogo = 12 - birthmo
print(monthstogo, "months until your birthday")
```

Debugging Steps

The Traceback shows the program fails on line 1, which means the variable "birthmo" is not created in memory, and is not shown in Variable Explorer.

The Traceback message shows `ValueError: invalid literal for int() with base 10: 'June.'` The string input 'June' causes a ValueError when the `int()` function tries to convert the string to an integer.

How to Resolve the Issue

I am going to add “try” and “except” logic to handle the ValueError exception.

Good Code

```
try:
    birthmo = int(input('what month were you born?'))
    monthstogo = 12 - birthmo
    print(monthstogo, "months until your birthday")
except ValueError:
    print('enter a number, no letters')
```

Reference

These topics from previous chapters are a good reference for this example.

- Chapter 5 - [Traceback](#)
- Chapter 5 - [Try and Except](#)
- Chapter 5 - [ValueError](#)
- Chapter 6 - Check [Object Type](#)

Ex 7.22 Name Error

Description: When I try to use “plot” there is a NameError.

Intended Outcome

Using the “matplotlib” library I want to plot a chart.

Actual Result

When I run the code, the [Console](#) displays a NameError and highlights line 2.

Incorrect Code

This is the Example 22 code before any changes.

```
import matplotlib.pyplot as plot
plt.plot([1, 2, 3, 4], [25, 30, 29, 31])
plt.ylabel('age')
plt.xlabel('participants')
plt.show()
```

Debugging Steps

The NameError indicates the object can't be found. When I imported the library on line 1, I used "plot," and on the other lines I used "plt."

How to Resolve the Issue

Update line 1 to use "plt."

Good Code

```
import matplotlib.pyplot as plt
plt.plot([1, 2, 3, 4], [25, 30, 29, 31])
plt.ylabel('age')
plt.xlabel('participants')
plt.show()
```

Reference

These topics from previous chapters are a good reference for this example.

Chapter 5 - [NameError](#)

Ex 7.23 Value Error

Descriptio n: Invalid data passed to method causing ValueError.

Intended Outcome

I want to remove one item from my list.

Actual Result

When the program runs it halts with a `ValueError` on line 3. A `ValueError` is raised when a function or method gets an argument of correct type but improper value.

ValueError: list.remove(x): x not in list

Incorrect Code

This is the Example 23 code before any changes.

```
fruits = ['apple', 'orange', 'grape']  
myfruit = 2  
fruits.remove(mylfruit)
```

Debugging Steps

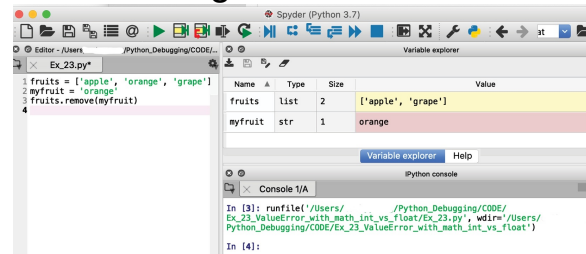
Line 3 uses the “remove” method. I would like to inspect the list object to see what methods are available.

1. In the Console, type **help(fruits)** . The interpreter returns a list of methods available, showing the “remove” uses the value of a list item.
2. In the Editor, I could position my cursor in front of “remove” and press Cntrl + I. The Help pane displays the same information on the remove method.

How to Resolve the Issue

Instead of using the value “2”, I update the value of “myfruit” to “orange.” When I rerun the program there is no error, and Variable

Explorer shows the value “orange” was removed from my list.



Good Code

```
fruits = ['apple', 'orange', 'grape']  
myfruit = 'orange'  
fruits.remove(myfruit)
```

Reference

These topics from previous chapters are a good reference for this example.

Chapter 4 - [Interactive Mode](#)

Chapter 4 - [Help\(\)](#)

Chapter 5 - [ValueError](#)

Chapter 5 - [RuntimeError](#)

Ex 7.24 Divide by Zero Error

Description : Calculation causes a ZeroDivisionError.

Intended Outcome

The program retrieves the current GBP exchange rate, and then converts “gbp” to the equivalent USD value.

Actual Result

When the program runs, a `ZeroDivisionError` from line 7 is displayed in the [Console](#)

Incorrect Code

This is the Example 24 code before any changes.

```
from bs4 import BeautifulSoup
from urllib.request import urlopen
usd, gbp, gbpx = 10.0 , 20.0 , 0.00
html2 = urlopen('https://usd.fxexchangerate.com')
soup2 = BeautifulSoup(html2, 'xml')
tables2 = soup2.findChildren('td')
gbp = gbp/gbpx
print("gbp converted to USD is:", gbp)
```

Debugging Steps

1. Variable Explorer shows the value of “gbpx” is zero. In this example, I omitted the line to retrieve the GBP exchange rate.

How to Resolve the Issue

In addition to adding the line of code to retrieve the GBP exchange rate from a web page, I added code to handle when “gbpx” causes an exception. In Chapter 4 I also added [logging](#) to handle this type of error.

Good Code

```
from bs4 import BeautifulSoup
from urllib.request import urlopen
usd, gbp, gbpx = 10.0 , 20.0 , 0.00
html2 = urlopen('https://usd.fxexchangerate.com')
soup2 = BeautifulSoup(html2, 'xml')
tables2 = soup2.findChildren('td')
try :
    gbpx = float(tables2[3 ].string[:6 ])
    gbp = gbp/gbpx
    print("gbp converted to USD is:", gbp)
except ZeroDivisionError:
    print('ZeroDivisionError where gbpx is:', gbpx)
```

Reference

These topics from previous chapters are a good reference for this example.

Chapter 4 - [Interactive Mode](#)

Chapter 4 - Debug Mode - [Variable Explorer](#)

Chapter 4 - [Logging](#)

Chapter 5 - [Traceback](#)

Chapter 5 - [ZeroDivisionError](#)

Ex 7.25 Math Logic Error

Description: There is a logic error in the math calculation.

Intended Outcome

The math calculation should return 10.

Actual Result

The calculation returns 40 instead of 10.

Incorrect Code

This is the Example 25 code before any changes.

```
myval = 60.0 / 3.0 * 2  
print("myval is:", myval)
```

Debugging Steps

To ensure multiplication occurs before the division, I add parentheses to my code.

How to Resolve the Issue

Add parentheses to change the [operator precedence](#) .

Good Code

```
myval = 60.0 / (3.0 * 2)  
print("myval is:", myval)
```

Ex 7.26 ValueError Assigning Date

Description: Operation on incompatible types. ValueError when assigning a datetime object.

Intended Outcome

After creating a datetime object with a date of 12/31/1999, I want to print the value to the Console.

Actual Result

The program halts with a **ValueError** exception. The Traceback indicates the error is on line 3.

Incorrect Code

This is the Example 26 code before any changes.

```
from datetime import datetime
d1 = datetime.strftime(datetime(1999, 13, 31), '%Y-%m-%d')
```

Debugging Steps

At a glance I can see that while my intentions were good, I made a mistake on line 3. It's obvious there is no month "13" and the statement on line 3 is invalid. The ValueError In the **Console** , also states the "month must be in 1..12."

When the cause of the ValueError is not obvious, you could use the Help pane, or search the Internet, to find correct arguments for a function or method.

How to Resolve the Issue

Line 3 needs updated to use "12" for the month instead of "13."

Good Code

```
from datetime import datetime
d1 = datetime.strftime(datetime(1999, 12, 31), '%Y-%m-%d')
```

Reference

These topics from previous chapters are a good reference for this example.

Chapter 4 - Interactive Mode

Chapter 5 - [Traceback](#)

Chapter 5 - [ValueError](#)

Chapter 6 - Check [Arguments](#)

Chapter 6 - Check [Function Return Objects](#)

Appendix - URLs

Arguments

The Python design and glossary entries for arguments are shown in this section. Also see Calls, Functions, and Parameters.

The design of keyword only arguments is covered in PEP 3102:

<https://www.python.org/dev/peps/pep-3102/>

The Python glossary entry for arguments:

<https://docs.python.org/3/glossary.html#term-argument>

Python terminology on arguments and parameters:

<https://docs.python.org/3.3/library/inspect.html#inspect.Parameter>

The difference between Arguments and Parameters:

<https://docs.python.org/3/faq/programming.html#faq-argument-vs-parameter>

Assert

The Python reference for assert statements is available on the docs.python.org website.

https://docs.python.org/3/reference/simple_stmts.html#the-assert-statement

Attributes

The Python glossary entry for “[attributes](#) ” is available on the [docs.python.org](#) website.

<https://docs.python.org/3/glossary.html#term-attribute>

Built-in Functions

The Python reference for [built-in functions](#) is available on the [docs.python.org](#) website.

<https://docs.python.org/3/library/functions.html>

Calls

The Python reference documentation explains “calling” functions and methods, and is available on the [docs.python.org](#) website.

<https://docs.python.org/3/reference/expressions.html#calls>

Classes

Information on Python Classes is available on the [docs.python.org](#) website.

9.3.2 Instantiation and Attribute References

9.3.3 Instance Objects, Attributes and Methods

9.3.4 Method Objects

9.9 Container Objects, Elements, and Iterators.

<https://docs.python.org/2/tutorial/classes.html>

Comparisons

The following link is the Python reference on comparisons.

<https://docs.python.org/3/reference/expressions.html#comparisons>

Containers

The docs.python.org website explains “containers” in the 9.9 section “Container Objects and Iterators.” The section 3.1 topic “Objects, values and types” also explains that objects that contain references to other objects are containers. Examples of containers are tuples, lists and dictionaries.

<https://docs.python.org/3.8/reference/datamodel.html#index-3>

The 3.1 topic “objects, values, and types” explains that “container” objects contain references to other objects. This “Data Model” reference is available on the docs.python.org website.

<https://docs.python.org/3/reference/datamodel.html#index-3>

doctest

The docs.python.org website has details on using the doctest module to search and validate examples in docstrings.

<https://docs.python.org/3/library/doctest.html?highlight=doctest>

Interactive Python examples are also available. These examples include reading in a text file

Functions

The Python reference documentation explains “functions,” and is available on the docs.python.org website.

https://docs.python.org/3/reference/compound_stmts.html#function

The Python tutorial for “Defining Functions” is available on the docs.python.org website.

<https://docs.python.org/3/tutorial/controlflow.html#defining-functions>

https://docs.python.org/3/reference/compound_stmts.html#function-definitions

The difference between function parameters and arguments is explained

in the FAQs available on the [docs.pythhon.org](https://docs.python.org/3/faq/programming.html#faq-argument-vs-parameter) website.

<https://docs.python.org/3/faq/programming.html#faq-argument-vs-parameter>

The Python glossary entry for “functions” is available on the [docs.pythhon.org](https://docs.python.org/3/glossary.html#term-function) website.

<https://docs.python.org/3/glossary.html#term-function>

Glossary

The official Python glossary is available on the [docs.pythhon.org](https://docs.python.org/3/glossary.html) website

<https://docs.python.org/3/glossary.html>

The if Statement

Information on the **if statement** is available on the [docs.pythhon.org](https://docs.python.org/3/reference/compound_stmts.html#the-if-statement) website

https://docs.python.org/3/reference/compound_stmts.html#the-if-statement

Immutable

The Python glossary explains the concept of “immutable” objects, and is available on the [docs.pythhon.org](https://docs.python.org/3/glossary.html#term-immutable) website.

<https://docs.python.org/3/glossary.html#term-immutable>

Inspect

The Python reference for the “inspect” library is available on the [docs.pythhon.org](https://docs.python.org/3/library/inspect.html) website.

<https://docs.python.org/3/library/inspect.html>

Interactive Mode

Interactive Mode in the **Console** is explained on the [ipython.readthedocs](https://ipython.readthedocs.io/en/stable/interactive/reference.html) website.

<https://ipython.readthedocs.io/en/stable/interactive/reference.html> .

Iterable and Iterations

The Python glossary explains the “iterable” concept, and is available on the [docs.python.org](https://docs.python.org/3/glossary.html#term-iterable) website.

<https://docs.python.org/3/glossary.html#term-iterable>

The [docs.python.org](https://docs.python.org/2/tutorial/classes.html) website explains Classes in the 9.9 section “Container Objects and Iterators.”

<https://docs.python.org/2/tutorial/classes.html>

Logging

The Python docs for the “logging library” are available on the [docs.python.org](https://docs.python.org/3/library/logging.html#logging.basicConfig) website.

<https://docs.python.org/3/library/logging.html#logging.basicConfig>

<https://docs.python.org/3.8/howto/logging.html>

<https://docs.python.org/3/library/logging.html>

Magic Functions

Functions that begin with the percent symbol are magic functions or magic commands and are sometimes implemented in a iPython kernel. Read more about magic functions at <https://ipython.readthedocs.io/en/stable/interactive/reference.html> .

Methods

The Python glossary explains “methods,” and is available on the [docs.python.org](https://docs.python.org/3/glossary.html#term-method) website.

<https://docs.python.org/3/glossary.html#term-method>

Objects

The Python glossary explains “objects,” and is available on the [docs.python.org](https://docs.python.org/3/glossary.html#term-object) website.

<https://docs.python.org/3/glossary.html#term-object>

Objects like data attributes have value or “state,” and objects like methods have “defined behavior.”

The 3.1 topic “objects, values, and types” in the “Data Model” reference is available on the [docs.python.org](https://docs.python.org/3/reference/datamodel.html#index-3) website.

<https://docs.python.org/3/reference/datamodel.html#index-3>

Parameters

The Python glossary explains “parameters,” and is available on the [docs.python.org](https://docs.python.org/3/glossary.html#term-parameter) website.

<https://docs.python.org/3/glossary.html#term-parameter>

There is information on arguments and parameters in the “inspect library.”

<https://docs.python.org/3.3/library/inspect.html#inspect.Parameter>

The difference between Arguments and Parameters is explained in the FAQs.

<https://docs.python.org/3/faq/programming.html#faq-argument-vs-parameter>

The pass Statement

Information on the **pass statement** is available on the [docs.python.org](https://docs.python.org/3/reference/simple_stmts.html#the-pass-statement) website

https://docs.python.org/3/reference/simple_stmts.html#the-pass-statement

The return Statement

Information on the **return statement** is available on the [docs.python.org](https://docs.python.org/3/reference/simple_stmts.html#the-return-statement) website

https://docs.python.org/3/reference/simple_stmts.html#the-return-statement

State

The Python glossary explains the “state” of data attributes, or objects with value.

<https://docs.python.org/3/glossary.html#term-object>

Statements

The Python glossary explains “statements,” and is available on the [docs.python.org](https://docs.python.org/3/glossary.html#term-statement) website.

<https://docs.python.org/3/glossary.html#term-statement>

https://docs.python.org/3/reference/simple_stmts.html

timeit

Information on the `timeit()` function is available on the [docs.python.org](https://docs.python.org/3/glossary.html#term-statement) website

<https://docs.python.org/3/library/timeit.html>

The try Statement

Information on the **try statement** is available on the docs.python.org website

https://docs.python.org/3/reference/compound_stmts.html#the-try-statement

Types

The Python glossary explains “types,” and is available on the docs.python.org website.

<https://docs.python.org/3/glossary.html#term-type>

The 3.1 topic “objects, values, and types” in the “Data Model” reference is available on the docs.python.org website.

<https://docs.python.org/3/reference/datamodel.html#index-3>

Values

The 3.1 topic “objects, values, and types” in the “Data Model” reference is available on the docs.python.org website.

<https://docs.python.org/3/reference/datamodel.html#index-3>

Conclusion

Einstein said, “If you can’t explain it simply, you don’t understand it well enough.” Learning new things is a passion of mine, and I’ve found the process of organizing notes, creating illustrations, and pondering how to craft clear examples helps me grasp concepts. Then too, it’s nice to go back in a year when I’ve forgotten something and refer to a solid example.

Thank you for reading along with me through the interesting topics and less than thrilling subjects. If the result is you have mastered new features, it was worth it! I’d love to hear the cool things you’re doing with Python, so please don’t hesitate to leave comments in a review.

Index

?! = (Not Equal) - See Comparison Operators, 3.14, Appendix Reference

?, 4.8

...: (iPython session), 4.7

%debug, 4.3

<, 3.14, Appendix Reference

< = (Less than or Equal To), 3.14

<=, 3.14, Appendix Reference

==, 3.14, Appendix Reference

>, 3.14, Appendix Reference

>=, 3.14, Appendix Reference

Anaconda, Ch 2

Arbitrary Number of Arguments (see Function, 3.17

Arguments (see Functions), 3.17, 6.9, 7.6, Appendix Reference

Assert, 5.5

Assign, Ch 3

Assignment statement, Ch 3

Attribute (also see value), 2.19, 3.19, Appendix Reference

Behavior (see Function or Method), Appendix Reference

Block of Code (See Suite), Ch 3

boolean, 3.6

Breakpoint, 4.5

Call Signature, 4.8, 6.9

Calling a Function, 3.17

Calls, Appendix Reference

Case sensitive , 3.2

Classes, 2.4, Appendix Reference

Code Block, 3.16

Colon, 3.2

Comment, Ch 3

Comparison Operators, 3.14

Console, Ch 2, 4.9

Container, Appendix Reference

Control Statements, 3.15

Convert Data Type, 3.6

Counter, 3.15

Data scrubbing,

Data type, 3.6

Debug Mode, 4.3

Define a Function, 3.17

Defined Behavior (see Methods), Appendix Reference

Dictionary, 3.12

Dir(), 4.8

Divide and Conquer, 4.8, 4.11

DocString (also see Inspect and Signature), 3.18, 4.9

Editor, Ch 2

Elements (see Classes), Appendix Reference

Else Statement, 3.15

Endless Loop, 7.1

Except (see try and except), 5.3

- float, 3.6
- Focused Testing, 4.11
- For Statement, 3.15, 7.20
- Functions,
 - Function Return Values, 3.17
- Global Variables, 4.8
- help() function, 4.8
- id() function, 3.4, 4.9
- IDE, Ch 2
- Identifier (Objects), 3.2, 3.3
- If..., 3.15
- Immutable, 3.4, 4.9, Appendix Reference
- in (see Comparison Operators), 3.14, Appendix Reference
- Increment Counter, 3.15, 4.8
- Indentation, 3.16, 4.3
- Index, Ch 3
- IndexError, 7.1
- Infinite Loop, 7.1
- Inspect, 3.18, 6.19
- Instance (see Classes), Appendix Reference
- Instatiation (See Classes), Appendix Reference
- integer, 3.6
- Integrated Desktop Environment, Ch 2
- Interactive Mode, 2.10, 4.1, 4.8
- Introspection, 4.8
- ipdb prompt, 4.7

- iPython Session, 2.10, 4.8
- is (see Comparison Operators), 3.14, Appendix Reference
- is not (see Comparison Operators), 3.14, Appendix Reference
- Iterable, Appendix Reference
- Iterate (Loop), 3.10, 3.15
- Keyword Arguments, 3.17
- Keywords, 3.2
- len (length), 6.8
- List Index Out of Range, 7.1
- Lists, 3.10
- Local Variables, 4.8
- Logging, 4.9
- Magic Functions, 4.3, 4.8, 5.1
- Method (also see Functions), Appendix Reference
- Mutable, Ch 3
- Namespace, 4.8
- Naming Conventions, Ch 3
- Nested, 3.16
- None, 3.6, 3.17, 6.6
- Not Equal Comparison Operator != , 3.14, Appendix Reference
- not in (see Comparison Operators), 3.14, Appendix Reference
- Numbers, 3.7
- Objects, 3.3, Appendix Reference
- Optional Arguments, 3.17
- Parameters, 3.17, Appendix Reference
- PEP 3131, 3.2

Plural - Naming Identifiers, 3.2
Positional Arguments, 3.17
Preferences, PEP8,
Prompt (Console), 4.7
Pseudocode, 5.1, 7.35
Python, Ch 2
Raise, 5.4
repr(), string representation (whitespace), 4.8, 7.39
Reserved Keywords, 3.2
Return values, 3.17, 6.10
Run, Ch 2
Scope, 3.4, 4.9
Script, Ch 2
Set, 3.13
Signature (see Inspect), 3.18, 6.19
Singular - Naming Identifiers, 3.2
Spaces, also see Whitespace, Ch 3
Special Characters, 3.2
Spyder, Ch 2
State, Appendix Reference
Statements, 3.1, 3.15
str, 3.6
String representation (see repr()), 7.39
Strings, 3.8
Style Guide for Python, see PEP8,
Suite (Block of Code), 3.16, 4.2

Syntax, 3.2

Test data, 4.12

timeit(), 4.10, 5.1

Try and Except statements, 5.3

Tuples, 3.11

Type, 3.6, 6.7, Appendix Reference

Type(), 4.8

Underscore, 3.2, 3.7

Unicode, 3.2

Value, Ch 3

Variable Explorer, 4.54

Variables (also see Classes), 2.14, 3.5

While Loop, 3.15, 7.6

Whitespace, 6.6, 7.39