2ND EDITION

LEARN POWERSHELL SCRIPTING IN A MONTH OF LUNCHES

- Scripting language
- Scripting environment
- PowerShell pipeline
- Parameter binding

- Avoiding bugs
- Basic function
- Advanced functions
- Script module

- Objects
- Filling out a manifest
- .net framework
- Pipelines

JAMES PETTY · DON JONES
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Learn PowerShell Scripting in a Month of Lunches, Second Edition

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welcome

Welcome to *Learn PowerShell Scripting in a Month of Lunches, Second Edition*. I'm glad you have decided to join us as I update and revise this classic book.

This book is for people who already work with PowerShell, and now want to start using it to its maximum functionality. To automate complex tasks and processes, you need to learn scripting, and that is what this book will teach you. The goal is to provide you with all the fundamental information you need to start scripting and creating basic PowerShell tools. If you are already scripting, we think this book can teach you better and more ways to do it.

Most of the preliminary information you need is covered in chapter 1, but here are a few things we should mention up front. First and foremost, we strongly suggest that you follow along with the examples in the book. In order to follow along, you'll need PowerShell installed. This book was written based on PowerShell 7.2, but honestly, 99% of the book also applies to earlier versions of Windows PowerShell.

You'll also need to install a script editor. Though Windows PowerShell's Integrated Script Editor (ISE) is included on client versions of Windows, we recommend removing it, since the PowerShell team has not put any maintenance or support into it since Windows 7 was released. Microsoft recommends Visual Studio Code (VS Code), which is free and cross-platform. Download that, and in chapter 2 we'll show you how to set it up.

Finally, you need to be able to run the PowerShell console, and your editor, "as Administrator" on your computer, mainly so that the administrative examples we're sharing with you will work.

Regarding Linux, mac and other operating systems, Visual Studio Code and PowerShell are both cross-platform. Every single concept and practice in this book applies to PowerShell running on systems other than Windows. But the examples we use will, as of this writing, only run-on Windows.

Thanks for joining us!

If you have any questions, comments, or suggestions, please share them in Manning's liveBook Discussion forum.

—James Petty

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1 Before you begin

PowerShell has been around for over 15 years, but it's been a fantastic journey. If you missed the memo, PowerShell is now cross-platform, meaning it's available on more than just Microsoft Windows. I am still blown away that Microsoft has open-sourced PowerShell. It was initially created to solve the specific problem of automating Windows administrative tasks, but frankly, a much simpler "batch file" language would have sufficed. PowerShell's inventor, Jeffrey Snover, and its entire product team had a much grander vision. They wanted something that could appeal to a broad, diverse audience. In their vision, administrators might start very simply by running commands to accomplish administrative tasks quickly—that's what the previous book, *Learn Windows PowerShell in a Month of Lunches*, focused on. The team also imagined more complex tasks and processes being automated through varying complex scripts, which is what this book is all about. The PowerShell team also envisioned developers using PowerShell to create all-new units of functionality, which we'll hint at throughout this book. Just as your microwave probably has buttons you've never pushed, PowerShell likely has the functionality you may never touch because it doesn't apply to you. But with this book, you're taking a step into PowerShell's deepest functionality: scripting. Or if you buy into our worldview, *toolmaking*.

1.1 What is toolmaking?

We see a lot of people jump into PowerShell scripting much the same way they'd jump into batch files, VBScript, Python, and so on. Nothing wrong with that. PowerShell is able to accommodate a lot of different styles and approaches. But you end up working harder than you need to unless you take a minute to understand how PowerShell really *wants* to work. We believe that *toolmaking* is the real way to use PowerShell.

PowerShell has a strong ability to create highly reusable, context-independent *tools*, which it refers to as *commands*. Commands typically do one small

thing, and they do it very well. A command might not be terribly useful by itself, but PowerShell is designed to make it easy to "snap" commands together. A single LEGO brick might not be much fun (if you've ever stepped on one in bare feet, you know what we mean), but a box of those bricks, when snapped together, can be amazing (hello, Death Star!). That's the approach we take to scripting, and it's why we use the word *toolmaking* to describe that approach. We believe that your effort is best spent making small, self-contained tools that can "snap on" to other tools. This approach makes your code usable across more situations, which saves you work. This approach also reduces debugging and maintenance overhead, which saves your sanity. And it's the approach we'll teach you in this book.

1.2 Is this book for you?

Before you go any further, you should make sure this is the right place for you. This is an entry-level book on PowerShell scripting, but because we focus as much on process and approach as on the syntax, it's fine if you've already been scripting for a while and are just looking to improve your technique or validate your skillset. That said, this isn't an entry-level book on PowerShell itself. If you're going to continue successfully with this book, you should be able to answer the following right off the top of your head:

1. What command would you use to query all instances of Win32_LogicalDisk from a remote computer? (Hint: if you answered `Get-WmiObject`, you're behind the times and need to catch up if this book is going to be useful for you.)
2. What are the two ways PowerShell can pass data from one command to another in the pipeline?
3. Well-written PowerShell commands don't output text. What do they output? What commands can you use to make that output prettier on the screen?
4. How would you figure out how to use the `Get-WinEvent` command if you had never used it before?
5. What are the different shell execution policies, and what does each one mean?

We're not providing you with answers to these questions—if you're unsure of any of them, then this isn't the right book for you. Instead, we'd recommend *Learn Windows PowerShell in a Month of Lunches* from Manning (https://www.manning.com/books/learn-powershell-in-a-month-of-lunches). Once you've worked your way through that book and its many hands-on exercises, this book will be a logical next step in your PowerShell education.

We also assume that you're pretty experienced with the Windows operating system because our examples will pertain to that.

1.3 Here's what you need to have

Let's quickly run down some of what you'll need to have to follow along with this book.

1.3.1 PowerShell version

We wrote this book using PowerShell 7.2, but honestly, 99% of the book applies to earlier versions of Windows PowerShell. Download PowerShell from https://docs.microsoft.com/en-us/powershell/. Now, look: Don't go installing new versions of PowerShell on your server computers without doing some research. Many server applications (we're looking at you, Exchange Server) are picky about which version of PowerShell they'll work with, and installing the wrong one can break things. Also, be aware that each version of PowerShell supports only specific versions of Windows—For this book, we are using Windows 11 and macOS.

We are using PowerSHell 7.2 (or higher as the newer version comes out), but most of the content will work on Windows PowerShell (5.1), although we haven't tested everything against that version. The content we're covering is so core to PowerShell, so stable, and so mature that it's essentially *evergreen*, meaning it doesn't really change from season to season. We use free e-books on PowerShell.org to help teach the of-the-moment, new-and-shiny stuff that relates to a specific version of PowerShell; this book is all about the solid core that remains stable.

1.3.2 Administrative privileges

You need to be able to run the PowerShell console, and your editor "as Administrator" on your computer, mainly so that the administrative examples we're sharing with you will work. If you don't know how to run PowerShell as an Administrator of your computer, this probably isn't the right book.

1.3.3 Script editor

Finally, you'll need a script editor. Windows PowerShell's Integrated Script Editor (ISE) is included on client versions of Windows and only works with Windows PowerShell. We recommend you remove this from your machine to begin with, as the PowerShell team has not put any maintenance or support

into it since Windows 7 was released. These days, Microsoft recommends Visual Studio Code (VS Code), which is free and cross-platform. Download that, and in chapter 2, we'll show you how to set it up for use with PowerShell. Start the download at https://code.visualstudio.com/.

NOTE

Visual Studio Code and PowerShell are both cross-platform. Every single concept and practice in this book applies to PowerShell running on systems other than Windows. But the *examples* we use will, as of this writing, only run-on Windows. We recommend sticking with Windows unless you're willing to be very patient and perhaps translate our running examples into ones that will run on other operating systems.

1.4 How to use this book

You're meant to read one chapter of this book per day, and it should take you under an hour to do so—except in one case, where we have a Special Bonus Double Chapter, which we'll call to your attention when we get there. Spend some additional time, even a day or two, completing any hands-on exercises at the chapter's end. *Do not* feel the need to press ahead and binge-read several chapters at once, even if you have an exceptionally long lunch "hour." Here's why: We're going to be throwing a lot of new facts at you. The human brain needs time—and sleep!—to sort through those facts, connect them to things you already know, and start turning them into *knowledge.* Cognitive science has identified some consistent limits to how much your brain can successfully digest in a day, and we've been careful to construct each chapter with those limits in mind. So, seriously—one chapter per day. Try to get in at least three or four chapters per week to keep the narrative in mind and make sure you're doing the hands-on exercises we've provided.

TIP

We'd rather see you repeat a chapter and its hands-on exercises for two or three days in a row to ensure it's cemented in your mind. Doing that, rather than trying to binge-read many chapters in just a day or two, will get this stuff into your brain more reliably.

And speaking of those exercises—*do not* just skip ahead and read the sample solutions we've provided. Again, cognitive science is clear that the human brain works best when it learns some new facts and immediately uses them. Even if you find a particular exercise to be a struggle, the struggle itself is what forces your brain to focus and bring facts together. Before you consult the sample solution for an easy answer, it's better to go back and skim through previous chapters. Constructing the answer in that fashion is what will make the information stick for you. It's a bit more work for you, but it'll pay off, we absolutely promise. If you take the lazy approach, you're just cheating yourself, and we don't want that for you.

1.5 Expectations

Before you get too far into the book, we want to make sure you know what to expect. As you might imagine, the book's topic is pretty big, and there's a lot of material we could cover. But this book is designed for you to complete in a month of lunches, so we had to draw the line somewhere. Our goal is to provide you with fundamental information that we think everyone should have in order to start scripting and creating basic PowerShell tools. This book was never intended as an all-inclusive tutorial.

1.6 How to ask for help

You're welcome to ask us for help in Manning's online author forum, which you can access through https://www.manning.com/books/learn-powershell-in-a-month-of-lunches, But we encourage you to consider an online forum like PowerShell.org. We monitor the Q&A forums there, but, more importantly, you'll find hundreds of other like-minded individuals asking and answering questions. The important thing with PowerShell is for you to engage and become part of its community, meet your peers and colleagues, and become a contributor yourself in time. PowerShell.org offers tips-and-tricks videos, free e-books, an annual in-person conference, and a ton more, and it's a great way to start making PowerShell a formal part of your career path.

1.7 Summary

Hopefully, at this point, you're eager to dive in and start scripting—or, better yet, to start *toolmaking*. You should have your prerequisite software lined up and ready to go, and you should have a good idea of how much time you'll need to devote to this book each week. Let's get started.

2 Setting up your scripting environment

I know you are ready to jump feet first into the deep end of the scripting pool. We need to take some time to make sure you have an adequate environment set up to use throughout this book. This chapter may be a lunch and a half, but you must follow along with each step in this chapter to make sure you have an environment where you can safely complete the hands-on labs that will appear at the end of most chapters.

2.1 The Operating System

While PowerShell is cross-platform for the duration of this book, we will be primarily focusing on the Windows operating system, since PowerShell is still prominently being used on Windows devices. The first thing you're going to need is a computer running Windows 10 or 11. You could use a Windows 7 computer but that is out of support by now so you should probably upgrade if you can. If you don't own a computer running Windows (maybe you are a Mac or Linux person), that's fine. You can spin up a Windows 11 VM in your favorite cloud provider. Power it on when you need it and turn it off when you are done with lunch for the day. You can also follow along with a Windows Server (2019 or Higher) if that is what you have available.

2.2 PowerShell

It shouldn't be a surprise that you need PowerShell installed for the remainder of this book. However, it should be noted that we will be using PowerShell 7, not the Windows PowerShell (5.1) which comes installed by default on your system. PowerShell 7 (which, from this point forward, will be referred to as simply PowerShell) needs to be installed. If you followed along with Learn PowerShell in a Month of Lunches 4th edition, then you should have this installed already. Instructions on how to install PowerShell can be

found all over the internet but here is a link to the official GitHub repository which has the latest installation instructions. https://github.com/powershell/powershell You can also use your favorite package manager such as Chocolatey or Winget. We do not recommend installing a prelease, preview, or beta version. We will be sticking with PowerShell 7.2.x for this book as that is the long-term support version of PowerShell. You can follow along with 7.3 or higher if you wish and there shouldn't be any issues.

2.3 Administrative Privileges and Execution Policy

You need to ensure that you have the ability to run PowerShell "as Administrator" on your **computer**. On a company-owned computer, that might not be possible, so it's worth checking. First, start the PowerShell console (press Windows-R, type `powershell`, and press Enter). If the window title bar doesn't say Administrator, right-click the PowerShell icon in the taskbar and select Run as Administrator. That should open a new window that *does* say Administrator in the title bar (you may get a User Access Control prompt beforehand, which you'll need to allow). If that doesn't work, *stop*. You're going to have difficulty following along with the examples in this book, and you need to resolve your Administrator access before you proceed.

With the shell open as Administrator, run `Get-ExecutionPolicy`. This needs to return something other than `AllSigned`, such as `RemoteSigned`, `Unrestricted`, or `Bypass`. If it doesn't, you can try running `Set-ExecutionPolicy RemoteSigned`. If that works, you're good to go. But if you get any errors or warnings, then your execution policy probably didn't change, and you need to resolve that with your company's IT team before you'll be able to follow along with this book. Pop over to the forums on PowerShell.org (https://forums.powershell.org/) if you need some help figuring this out!

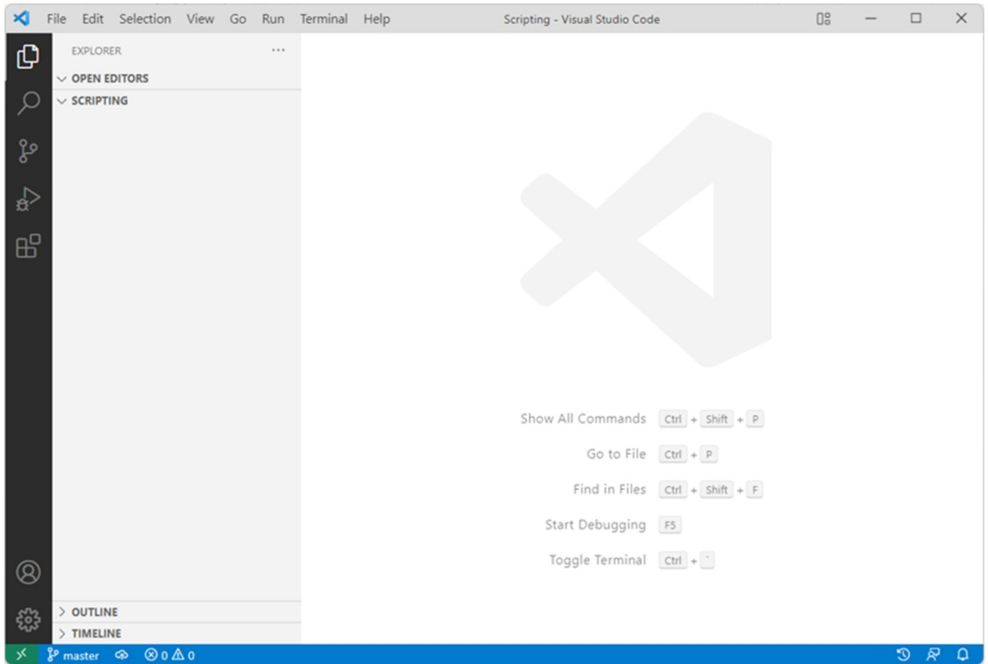
2.4 Script Editors

You are going to need a scripting editor in order to follow along with the

examples and labs. In 2017 Microsoft announced it would deprecate the Integrated Script Editor (ISE) and PowerShell 7 doesn’t run in the ISE. We recommend (and will be using) Microsoft’s free, cross-platform Visual Studio Code (VSCode). Head over to https://code.visualstudio.com to download and install it. As always, we recommend you download and install the latest stable release and not preview or insiders build. You can use any editor you prefer but for this book we will be using VSCode and we will assume you are as well.

Once you have VSCode installed it will look similar to this. We have changed to the Light+ theme so that you can see it when it’s printed.

Figure 2.1 Opening VSCode

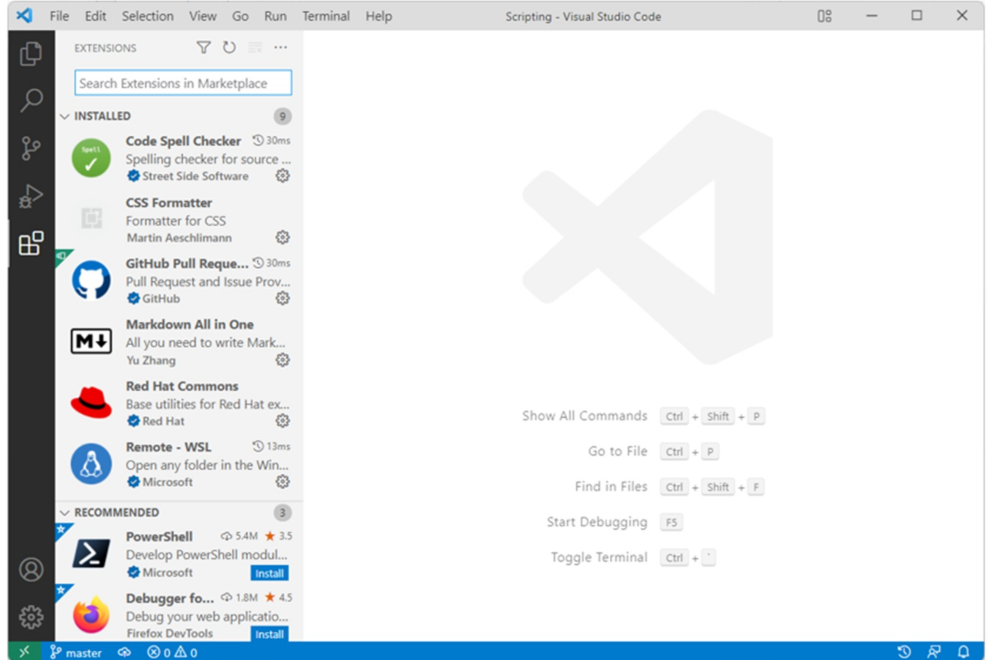


Every so often, you’ll find that VSCode has updated itself and wants to restart. Let it—the update takes only a second, and it’s a good way to make sure you have the most stable release.

Right away, you’ll want to install the extension that lets VSCode understand PowerShell. In the vertical ribbon on the left, the bottom icon provides access to VSCode’s *extensions*. Selecting that should bring up a screen somewhat

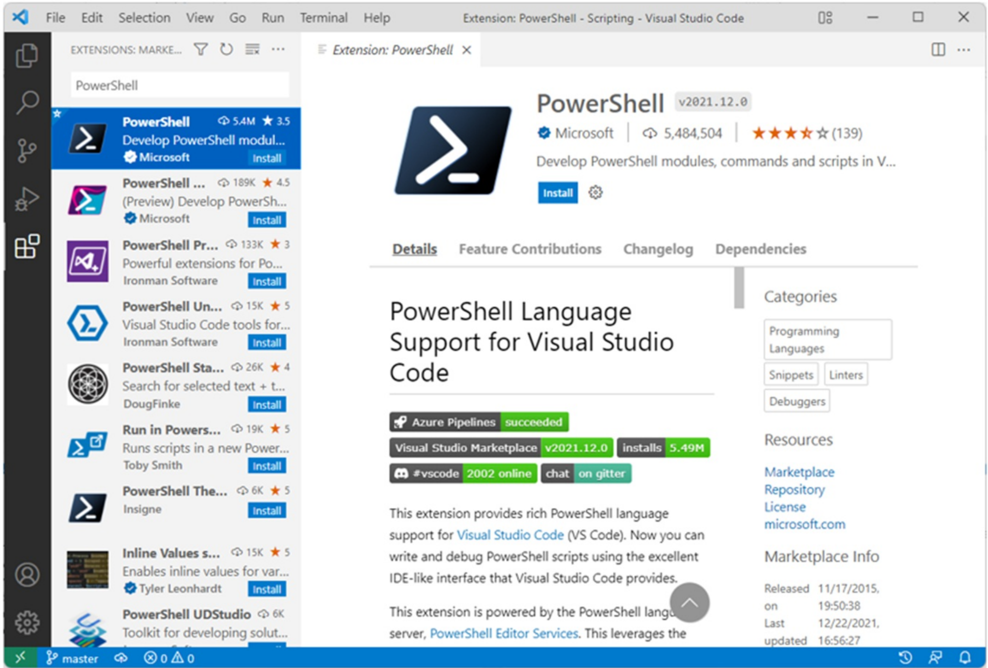
like the one in figure 2.2; you’ll notice that we have several extensions already installed.

Figure 2.2 The Extensions panel lets you install and manage VSCode add-ins.



The PowerShell extension isn’t installed yet so lets install it. In the search bar type PowerShell. Click the PowerShell extension (make sure its not the preview version). Then click install.

Figure 2.3 Installing the PowerShell Extension



The PowerShell extension for VSCode is updated very frequently and you will get a notification in the bottom right hand corner of the VSCode window. We always encourage you to update the extension whenever a new release is available. Here are a few more type that we encourage your to set.

1. You can set the default file extension to PS1 by adding this to your settings.json file
   "files.defaultLanguage": "powershell" (the value powershell MUST be in all lower case)
2. I also highly encourage you to add colors to you brackets. Add the following to your settings.json file.
   "editor.bracketPairColorization.enabled": true

This book isn’t intended to be a tutorial on VSCode, of course, but as we go we’ll point out useful tips and tricks for working more efficiently with PowerShell in this editor.

NOTE

We know a lot of you are still stuck with Windows PowerShell. If you’re bound and determined to use the PowerShell ISE and Windows PowerShell (5.1), go ahead. You’ll have a lot less functionality (even with stellar add-ons

like ISE Steroids), especially when it comes to debugging. At this point, VSCode is the official editor for PowerShell, and we don’t know why you wouldn’t want to use it, but it’s your computer!

2.5 Our Lab Environment

For this book I have the following lab set up. Four machines with the following names and operating systems.

A) Srv01 – Server 2019

B) Srv02 – Server 2019

C) DC01 – Server 2019

D) Client1 – Windows 10

I suggest that you set up an environment similar to this, if this is possible for you. It will just make it easier for you if your screen looks like the one I’ve used to run the examples and write this book. There are a few options for creating your lab. Of course, if you have the ability to deploy four VM’s on in a lab or dedicated space at work that is the best. If you are running Windows 10 or 11 Pro or Enterprise, you can enable Hyper-V and create a virtual lab on your local machine. There are other free, open source, and paid version to create VM’s on your local machine, just pick one that is right for you.

To create my lab, I used Automated lab. It’s a free and open-source project that works great for my needs. I have included my lab defincation file in the resources folder of this book for your reference.

2.6 Example Code

Finally, we strongly recommend that you download this book’s sample code. Manning hosts it in a zip file on this book’s page, **[I DON’T HAVE THE URL YET**]. The file is organized by chapter; there’s a text file for everything formatted as a code listing in the chapter. Later in the book, we’ll introduce

some modules. These too are organized under each chapter.

After you download the zip file, unzip it to someplace convenient (like your Documents folder or the root of C:\), and you should be ready to go. As you look through the code samples, you'll see that the module names are repeated. That's because subsequent chapters build on what came before. We don't necessarily expect you to import and use the modules, although we'll provide instructions to do so.

Finally, so there are no misunderstandings, let us be crystal clear that all the code samples in the book are for *educational* purposes only. Nothing should be considered ready for use in a production environment, even though you may be tempted.

2.7 Your Turn

Take some time to make sure you've downloaded the sample code and successfully installed VSCode and its PowerShell extension. If VSCode is *working*, you should be able to save an empty file with a .ps1 filename extension and then, in the editor, type something like `Get-P`. VSCode's IntelliSense should kick in and offer to autocomplete command names like Get-Process for you. If that's working, then you're clear to proceed. If not, stop here, and get it working. Again, we'll keep an eye on the forums at https://forums.powershell.org for questions; you're welcome to drop by there if you need help.

3 WWPD: What would PowerShell do?

Before we dive in lets have a quick conservation. What is the “right way to do things in PowerShell”. One of PowerShell’s advantages—and also one of its biggest disadvantages—is that it’s pretty happy to let you take a variety of approaches when you code. If you come from a VBScript background, PowerShell will let you write scripts that look a lot like VBScript. If you’re a C# person, PowerShell will happily run scripts that bear a strong resemblance to C#. But PowerShell is neither VBScript nor C#; if you want to take the best advantage of it and let it do as much heavy lifting for you as possible, you need to understand the PowerShell Way of doing things. We’re going to harp on this a *lot* in this book, and this is where we’ll start. But its also important to keep in mind that just because we did things a certain way that doesn’t mean it’s the only way. Just the way we prefer to do things. We generally follow the community best practices when it comes to scripting.

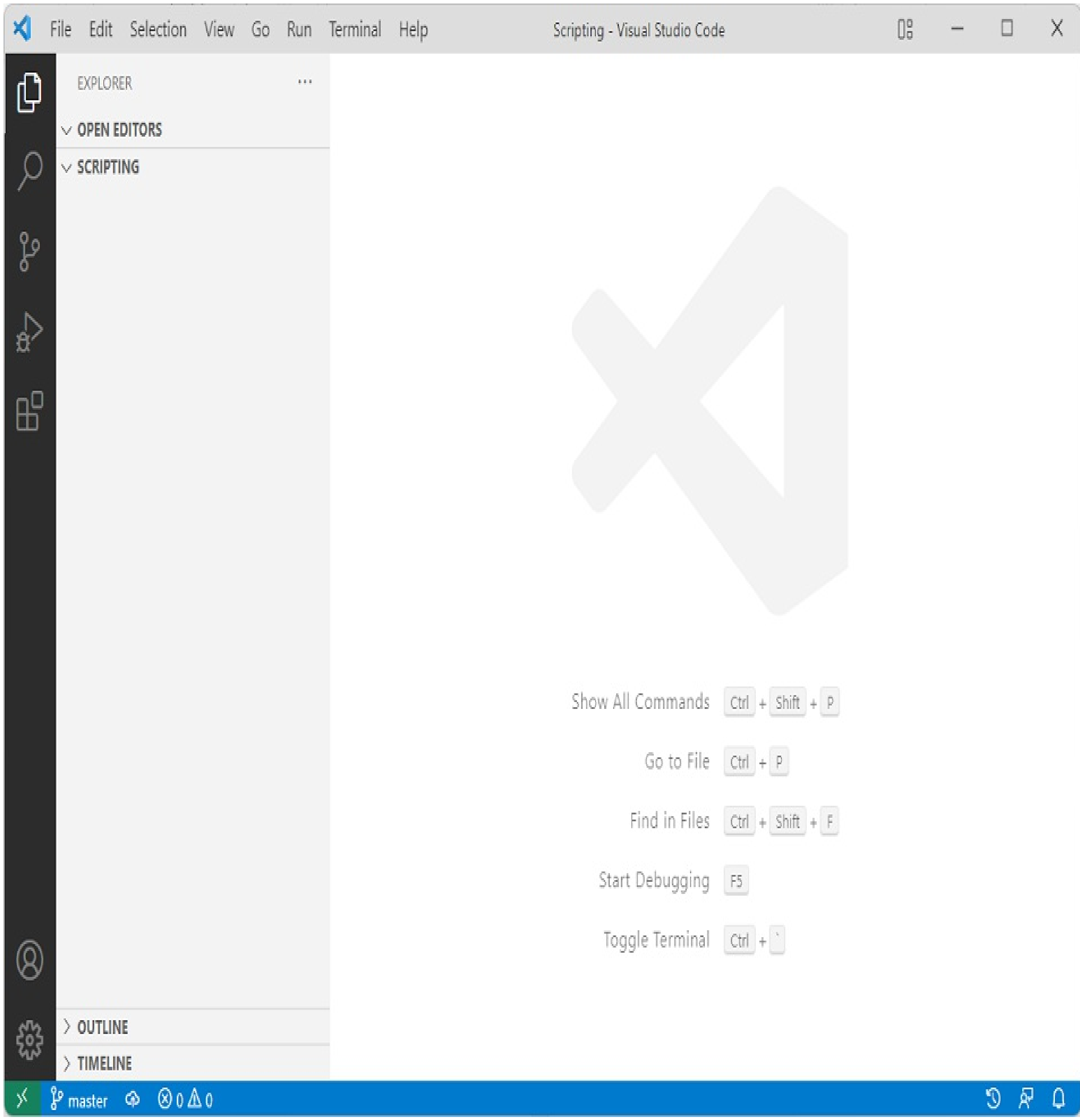
Think of it this way: A car is useful for getting from point A to point B, but there are many different ways in which you could do so. You could, for example, put the car in neutral, get out, and push it to point B. You could walk, ride a bike, or take the bus. Or, you could hitch a horse to the car, and let the horse pull it. Horses have been a great approach to transportation for centuries, so why change? But the most efficient way is to use the car as it was meant to be used: Fill it with gas, get in, and step on the accelerator. You’ll go faster than the horse could, you’ll expend less effort than you would by pushing, and overall you’ll be a happier, healthier traveler.

That’s what we want to do with PowerShell. Unhitch the horse, get in the car, and *go*.

3.1 One tool, one task

We are going to start out with a big one.

Figure 3.1 Scripting Rule number 1, A script should accomplish a single task



PowerShell is predicated on the idea of using small, single-purpose tools (you know them as cmdlets and functions) that you can string together in a pipelined expression to achieve amazing results with minimal effort. If you are coming from another programming or scripting background you know how long the code can be to on some commands. The `Sort-Object` command alonce can be tens of lines long in some languages. For instance, here's how

you’d write it in X:

```
Get-ciminstance win32_logicaldisk -filter 'drivetype=3' -computer
```

You should embrace this golden rule in your toolmaking endeavors. In fact, this is so critical that you will see this more that once we can promise. Please, please, please don’t try to create one gigantic script that does a dozen different things. Write small, single-purpose tools that do one thing, and do it very well. The tools you are creating should act and behave no different than any other PowerShell command you get out of the box.

The single-task tool rant

A lot of folks have a hard time with the “single-task tool” principle. We get it, it’s a new concept to many people, and it’s hard to adjust to it. Chapter 17 will focus on some before-and-after examples to help make the point even clearer. But we want to say something specific about it now.

It’s easy to think, “Well, provisioning a new user is a single task.” No, it isn’t. It’s a *process*, and if you think about how you’d perform it manually, you’d realize instantly that it consists of multiple actual tasks. You have to create the user, set up a home folder, assign a M365 license, create a mailbox, create a user library in SharePoint, etc... Were you to start coding the process, you’d create a tool for each task: new user, new home folder, M365 tasks, SharePoint account, and so forth (many of those tasks can be accomplished using tools Microsoft has already written). You’d then “connect” those tools together into a *process* by writing what we call a *controller script*. We’ll cover those later in the book.

Even something as simple as writing information to a CSV file is a single task (and PowerShell has a tool that does that). If you have a script that both produces new information *and* takes the time to format it as CSV and write it to a file, then you’re not only doing it wrong—you’re working too hard.

From this point on, start thinking about *making things smaller*. For any given process that you need to automate, what are the smallest units of work you can create to accomplish each task within the process? Can anything be made smaller or broken into multiple discrete pieces? This is the essence of

toolmaking.

3.2 Naming Your Tools

There are quite a few hot topics that we will cover in this book. If you browse the PowerShell forums (https://forums.PowerShell.org) or talk to anyone in any of the PowerShell slack or Discord channels, you'll find people who will stand their ground and argue with you on the "correct" way to write code. That's fine most of the time; their way is not *wrong* and everyone has a valid opinion. That is one of the beauties of PowerShell being Open-Source and being community driven. There are multiple ways to do things. Just because we show one way to do something in this book doen't mean it's the *only* way. It's just the way we feel is the best way to do things.

When it comes to time to name your tools, what naming convention should you use? A tool named `ListAllIISWebServersInTheIISWebFarm` is very self-explanatory, but that doesn't fit into the PowerShell model. As we discussed in the previous book *Learn PowerShell in a Month of Lunches 4th Edition*, PowerShell follows a `Verb-Noun` naming syntax.

- Start with a Verb. But not just any verb, PowerShell has a list of approved verbs (The word approved is more of a suggestion you can use any verb but lets stick with the approved ones). The PowerShell team does occasionally add new ones to the list.

Try it Now

Run the command Get-Verb and look at the output

- For the noun, always use a singular noun
- *User* as opposed to *Users*
- Prefix the noun with something meaningful to your company (never us *PS*). If your company name is Globalmantics then your tool could be called `Get-GlobalUser`.

Why are we so picky? Because PowerShell has a lot of code built around this naming convention and around the specific approved verbs. `Get-Command`, for

example, understands the difference between a verb and a noun and can help locate commands based on either. `Import-Module`, as another example, knows the approved verb list and issues warnings when you attempt to load unapproved verbs. Perhaps most important, all the cool kids in the PowerShell community will chuckle at you for using improperly constructed command names.

3.3 Naming Paramaters

Believe it or not parameter naming is just as important (some may say even more important) than command naming. Parameter naming, as you'll learn, is key to enabling commands to connect to each other in the pipeline. Parameter naming is also important for command discovery by using `Get-Command`.

Quiz Time

1. If you write a command that can connect to remote computers, what parameter name will accept those remote computer names or addresses?

2. If you write a command that can output to a data file, what parameter name will accept the file location and name?

3. If you write a command that can work over an existing PowerShell Remoting session, what parameter name might accept the session object to use?

You may need to research a bit to answer these quiz questions—and that's the point. When deciding on a parameter name, try to focus on the core, native PowerShell commands (rather than add-in modules like ActiveDirectory or something). What would *they* use in the same situation?

1. Core commands invariably use `–ComputerName` rather than an alternative like `–Host`, `-MachineName`, or something else.
2. Core commands are a bit inconsistent here, but *most* of them use either `–FilePath` or `–Path`. We'd go with a command like `Out-File`, which uses `–FilePath`, as our exemplar.
3. The core remoting commands, like `Invoke-Command`, perform this task,

and they do so using a `–PSSession` parameter.

Wondering if a parameter name is a good choice? Use PowerShell to see if other commands are using it:

```
get-command -CommandType Cmdlet -ParameterName ComputerName
```

If you don’t find a match, that doesn’t mean you *shouldn’t* use it, but there might be a better alternative.

The idea is to *be consistent.* Again, you’ll see how this becomes crucial when wiring up commands so that they can connect in the pipeline. A lot of under-the-hood stuff relies on consistent parameter naming, so don’t go thinking you’ve got a great reason to diverge from the norm.

Quiz Time

1. Why do you think using the parameter -Host is a bad idea?

a.When using Invoke-Command or Enter-PSSession we have the option to use -computername or -hostname. Computername uses WinRm and Hostname uses SSH to connect to the remote machine.

3.4 Producing Output

This is an area where observing PowerShell’s native approach to things can be misleading, because a lot goes on under the hood with PowerShell output. If you’ve read our book *Learn PowerShell in a Month of Lunches* (Manning, 2022), then you know some of this; if you haven’t, we heartily recommend you do so. But in brief

1. PowerShell commands, as you’ll learn in this book, produce *objects* as output. Objects are a form of structured data, not unlike an Excel spreadsheet. An object represents a row in the sheet, and each column in the sheet is essentially a *property* of the object. By referring to the property names, you can access their contents. Structured data output—

that is, objects—are at the deep core of what PowerShell is. If you ignore this maxim, your PowerShell experience will be miserable.

2. Objects are output and placed into the PowerShell *pipeline*, which ferries the objects to the next command in the pipeline. Commands therefore need to, in many cases, *accept* input from the pipeline, so that they can work in this execution model. You can continue this process for as long as you need. But realize that objects may change in the pipeline depending on what cmdlets you're using.
3. When the last command has output its objects to the pipeline, the pipeline carries the objects to the formatting system. At this point, the objects are still just structured data. Their properties don't appear in any particular order, and they aren't specifically destined to be displayed in any particular way.
4. The formatting system, through a fairly complex set of rules we covered in *Learn PowerShell in a Month of Lunches*, decides how to draw an onscreen display for the objects. This involves deciding to display a list or a table, coming up with column headers, and so on.
5. The result of the formatting system is a bunch of specialized formatting directives, meaning the original structured data is now gone. These directives are basically useful only for drawing an onscreen display or sending an equivalent to a text file, a printer, or another output device.

Your tools shouldn't be doing any of the work in steps 4 or 5. That is, you should focus on outputting useful, structured data in the form of objects—and explicitly *not* worry about what the results *will look like on the screen*. We can't tell you how many people we've seen bang their heads against their desk trying to create "attractive" output. We're going to show you how to do that *the PowerShell way*, which essentially involves educating the formatting system that fires off in step 4. But for your tools themselves, focus on getting the right data into the output, and don't worry about what that will look like on the screen.

3.5 Don't Assume

We've spent years teaching, writing, and speaking PowerShell to IT professionals literally all over the world. If there's one constant challenge we see people encounter, it's making assumptions about what PowerShell is and

how it should behave. There is a quote attributed to the ancient Greek philosopher Epictetus:

“It is impossible to begin to learn that which one thinks one already knows.”

As you work with PowerShell, especially if you have other programming or scripting experience, you’ll recognize many patterns. That is to be expected. When PowerShell was being developed, the product team looked at many, many languages to adopt ideas and principles that fit the paradigm they were building. (You should check out Don’s book *Shell of an Idea* if you want to know more about the history of how PowerShell was developed) But just because you recognize something that looks like Python, don’t assume it will behave like Python. We find that the people who approach PowerShell thinking they can treat it like some other language they know are the most frustrated. Here are some things to keep in mind:

- Although PowerShell has a rich and robust pipeline, it isn’t Bash. PowerShell’s pipeline works completely differently.
- Although running a command may produce a certain kind of onscreen output, that doesn’t mean that’s all the command produced. PowerShell’s “visuals” don’t always correspond exactly with its “internals.”
- Although PowerShell has scripting constructs like `If` and `ForEach`, it isn’t a full programming language. If you approach it as one, you’ll likely find yourself working at cross purposes with the shell.
- Although PowerShell uses .NET Framework for much of its functionality, PowerShell isn’t C#. PowerShell has become more programming language-ish over the years, but there are still times when the right answer is “Just do it in C#.” If you find yourself writing almost entirely in .NET classes and not in PowerShell commands, you could be at that point.

Perhaps most important, try not to drag your past experiences into PowerShell too much. PowerShell isn’t VBScript, Perl, Python, KiXtart, or batch; the more you try to treat it like those things, the more you’re going to struggle and be frustrated. Don’t try to force PowerShell to meet some preconception you might have. PowerShell is its own thing. *Learn PowerShell in a Month of Lunches* should have prepared you for *how*

PowerShell wants to be used; this book will prepare you to extend the shell the way it wants to be extended.

3.6 Avoid Innovation

We'll leave you with this related piece of advice: *Don't try to invent new ways of doing things. But wait, the whole point of this book is to make your own scripts isn't it?* The whole strength of PowerShell—quite literally the entire reason for its existence—is to create a consistent administrative surface from a sea of chaos. Don't contribute to the chaos by coming up with some novel approach. You may think to yourself, "Well, Microsoft really missed the boat on this one—I've got a much better way of doing this!" Stop thinking that way. The goal of creating tools in PowerShell isn't to do it *better* than Microsoft; it's to remain *consistent* with what has come before.

But contribute

We don't want to stifle you. If you have a great idea or suggestion about how Microsoft can do something better, make your voice heard.

PowerShell is now an open source project on GitHub (https://github.com/powershell/). Have an idea? Post an issue. Or even better, fork the GitHub repo, develop the improvement, and submit a pull request. You can have a say in what future versions of PowerShell look like!

3.7 Summary

All we're trying to stress in this chapter is that you need to take the time to observe how PowerShell approaches problems and try to emulate its approaches, rather than invent your own. Your results will end up being more comprehensible to others, will require less effort on your part, and will form a much more consistent solution within the shell.

Unlike a car, which you've obviously observed in everyday life—presumably noticing the lack of an attached horse—PowerShell's approach isn't always

obvious. Worse, it isn’t always consistent, because lots of different people, even inside Microsoft, have declined to follow our advice from this chapter. It’s worth the time to research a bit, especially the core commands provided by the PowerShell team, to discover PowerShell’s approach and emulate it as best you can.

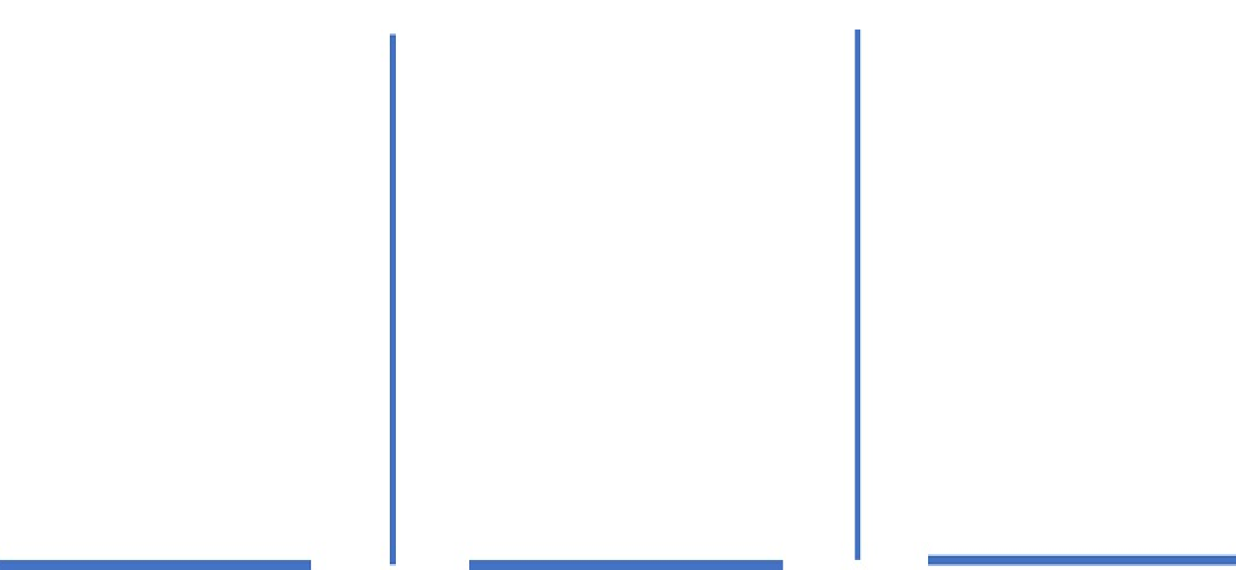
4 Review: Parameter binding and the PowerShell pipeline

Take traditional pipeline behavior from shells like Bash and Cmd.exe and mix in PowerShell's unique object-oriented nature. Now add a dash of Linux-style command parsing and what is the result? PowerShell's pipeline, a fairly complex and deeply powerful tool for composing tools into administrative solutions. To be a toolmaker is to understand the pipeline at its most basic level, and to create tools that take full advantage of the pipeline. Although we covered these concepts in *Learn Windows PowerShell in a Month of Lunches*, in this chapter we'll go deeper and focus on the pipeline as something to *write for*, rather than to just *use*.

4.1 The Operating System

Lets start with a little practice exercise. Grab a sheet of paper (or a tablet you can write on) and draw something similar to what you see below in Figure 4.1. Now, write some command names in those boxes. Maybe `Get-Process` in the first box, maybe `ConvertTo-HTML` in the second box, and perhaps `Out-File` in the third box.

Figure 4.1 Visualizing the Pipeline



TRY IT NOW

Go on—actually *draw* the boxes. We could have just repeated the finished figure here in the book, and believe us, our editor wanted us to, but there's value in you doing this physical thing for yourself.

This exercise may have seemed a bit silly but this is a good visual depiction of how PowerShell runs commands in the pipeline: As one command produces objects, they go into the pipeline *one at a time* and get passed on to the next command. At the end of the pipeline, when there are no further commands, any objects in the pipeline are passed to PowerShell's formatting system to be formatted for onscreen display.

The pipe symbols (**|**) in our diagram are concealing a great deal of under-the-hood functionality, and this is what's important to understand. It's easy enough to say, "PowerShell passes the objects from one command into the next one," but *how* does that happen?

4.2 It's all in the parameters

PowerShell uses two methods to dynamically figure out how to get data—that is, objects—out of the pipeline and "into" a command on the other side of the pipe. Both of these methods rely on the accepting command's parameters. In other words—and this is important—*the only way a command*

can accept data is via its parameters. This implies that when you design a command, and when you design its parameters, you're deciding how that command will accept information, including how it will accept information from the pipeline. This process is therefore not magic; it's a science, and it's decided in advance by whoever designed the command.

It can *look* magic, though. Consider this:

```
Get-Service | Where Status –eq "Running" | ConvertTo-HTML |
Out-File tats.html
```

We don't want you to go any further than this chapter until you understand why that command works. Start by embracing the fact that all commands only get their input by means of parameters. Period. No exceptions. Full stop. The problem is that, a lot of the time, you're not *typing* parameter names. Instead, PowerShell lets you use *positional* parameters, where the order of the values you provide implies the parameters those values get fed to. In order to dispel the magic, it's helpful to rewrite the command with every parameter spelled out in full:

```
Get-Service | Where-Object –Property Status –eq –Value "Running"
ConvertTo-HTML | Out-File –Path stats.htm
```

That `Where-Object` command is particularly interesting. We've used three parameters: `-Property`, the `eq` operator (which needs no value, because it's an operator), and `–Value`. You'll *never* see this written out this way in the real world, but writing it out is a useful way to understand that everything the command is doing is coming from parameters. The last piece of the magic is how objects of data are carried by the pipeline from one command to another. For that, PowerShell has two techniques it can use.

4.3 Pipeline: ByValue

PowerShell has a hardcoded preference to pass *entire objects* from the pipeline into a command. Because of that hardcoded preference, it will always attempt to do that before it tries to do anything else. In order to do so, the following must be true:

- The accepting command must define a parameter that supports accepting pipeline input ByValue.
- That parameter must be capable of accepting whatever type of object happens to be in the pipeline.

For example, let's refer back to your diagram, with `Get-Process` in the first block. What kind of object does that command produce? In PowerShell, try running `Get-Process | Get-Member`—the first line of output will contain the TypeName, which identifies the kind of object that the command produced. Turns out it's a `System.Diagnostics.Process` object.

Now, peruse the help for the second command we suggested. You'll want to first make sure you've run `Update-Help` so that you *have* help files, and then run `Help ConvertTo-HTML –ShowWindow` so that you can explore the complete help. Do you see any parameters of the command that are capable of accepting a `[Process]` object? Don't' worry, you didn't miss one because one doesn't exist.

But you probably *do* see a parameter capable of accepting an `[Object]` (or `[Object[]]`), right? In the Microsoft .NET Framework, `System.Object` is like the mother type for everything else. That is, everything *inherits* from the `Object` type. In PowerShell, `PSObject` (or "PowerShell Object") is more or less equivalent to `Object`. So, whenever you see that a parameter accepts `PSObject`, you know that it can accept basically anything. In the help for `ConvertTo-HTML`, you'll find an `–InputObject` parameter, which fulfills our two criteria:

- It can accept pipeline input using the ByValue technique.
- It can accept objects of the type `System.Diagnostics.Process`, because it can accept the more-generic `PSObject`.

Therefore, PowerShell will take the output of `Get-Process` and attach it to the `–Input-Object` parameter of `ConvertTo-HTML`. Reading the help for the second command, that parameter "specifies the objects to be represented in HTML." So, whatever you pipe into `ConvertTo-HTML` will be picked up, ByValue, by the `–InputObject` parameter, and will be "represented in HTML."

4.3.1 Introducing Trace-Command

The Pipeline can still be a bit tricky and hard to understand at first, and that's ok. Lucky for us PowerShell has a built-in way for you to see this passing-of-the-objects happening. It's called `Trace-Command`, and it's a really useful way to debug pipeline parameter binding. It'll show you, in detail, the decisions PowerShell is making and the actions it's attempting to take. To run the command, you'll run something like `Trace-Command –Name Parameterbinding –Expression { Your command goes here } –PSHost`. Keep in mind that your command *will actually run*, so you need to be careful not to run anything that could be damaging such as deleting a bunch of user accounts or deleting everyone's home folder, just to see what happens! This is not a replacement of -Whatif.

TRY IT NOW

Open up PowerShell and run the following command. Trace-Command -Name ParameterBinding -Expression {get-process | select -first 1} -PSHost and look at the output.

4.3.2 Tracing ByValue parameter binding

Let's apply `Trace-Command` to the current example. Here's the command we ran, which you should run, too:

```
PS C:\> trace-command -Expression { get-process | convertto-html
out-null } -Name ParameterBinding -PSHost
```

You'll notice that we ended our command with `Out-Null`; we did that to suppress the normal output of `ConvertTo-HTML`, to keep the output a little cleaner. You will, however, see PowerShell dealing with getting objects from `ConvertTo-HTML` into `Out-Null`, so it's a useful illustration.

You'll first see PowerShell attempt to *bind*—that is, attach—any `NAMED` arguments for `Get-Process`. There weren't any—we didn't specify any parameters manually in our command:

```
DEBUG: ParameterBinding Information: 0 : BIND NAMED cmd line args
```

```
[Get-Process]
```

PowerShell next looks for `POSITIONAL` parameters, which we also didn't have. PowerShell then checks to make sure that all of the command's `MANDATORY` parameters have been provided, and we pass that check:

```
DEBUG: ParameterBinding Information: 0 : BIND POSITIONAL cmd line
[Get-Process]
DEBUG: ParameterBinding Information: 0 : MANDATORY PARAMETER CHEC
cmdlet [Get-Process]
```

This entire process—named, positional, and then a mandatory check—repeats for the `ConvertTo-HTML` and `Out-Null` commands. This serves as an important lesson: Regardless of how a command is wired up to accept pipeline input, *specifying named or positional parameters always takes precedence*, because PowerShell binds those first. If we'd manually specified `–InputObject`, for example, then we'd have prevented the ByValue parameter binding from working, because we'd have "bound up" the parameter ourselves before ByValue was even considered:

```
DEBUG: ParameterBinding Information: 0 : BIND NAMED cmd line args
[ConvertTo-Html]
DEBUG: ParameterBinding Information: 0 : BIND POSITIONAL cmd line
[ConvertTo-Html]
DEBUG: ParameterBinding Information: 0 : MANDATORY PARAMETER CHEC
cmdlet [ConvertTo-Html]
DEBUG: ParameterBinding Information: 0 : BIND NAMED cmd line args
[Out-Null]
DEBUG: ParameterBinding Information: 0 : BIND POSITIONAL cmd line
[Out-Null]
DEBUG: ParameterBinding Information: 0 : MANDATORY PARAMETER CHEC
cmdlet [Out-Null]
```

The next thing that happens is PowerShell calling each of the three commands' `BEGIN` code. This is code that is executed once before any pipeline objects are processed. Not all commands specify any `BEGIN` code, but PowerShell gives them all the opportunity:

```
DEBUG: ParameterBinding Information: 0 : CALLING BeginProcessing
DEBUG: ParameterBinding Information: 0 : CALLING BeginProcessing
```

The next bit is a little surprising, because PowerShell is attempting to bind a

pipeline object to a parameter of `Out-Null`:

```
DEBUG: ParameterBinding Information: 0 :     BIND PIPELINE object
parameters: [Out-Null]
```

How the heck did anything even get into the pipeline at this point? Well, the previous command, `ConvertTo-HTML`, has clearly taken the opportunity to produce some output from its `BEGIN` code. Sneaky. Anyway, PowerShell now has to deal with that, even though the first command, `Get-Process`, hasn't even run yet!

Then comes something interesting. Here's what you'll see:

```
DEBUG: ParameterBinding Information: 0 : PIPELINE object TYPE =
[System.String]
DEBUG: ParameterBinding Information: 0 : RESTORING pipeline
parameter's original values
```

PowerShell identifies the type of object in the pipeline as a `System.String`. Take a minute and read the full help for `Out-Null`. Do you see any parameters capable of accepting a `String` from the pipeline using the ByValue method?

PowerShell is about to discover that the `–InputObject` parameter of `Out-Null` accepts either `Object` or `PSObject`, and so it's going to bind the output of `ConvertTo-HTML` to that `–InputObject` parameter:

```
DEBUG: ParameterBinding Information: 0 : Parameter
[InputObject] PIPELINE INPUT ValueFromPipeline NO COERCION
DEBUG: ParameterBinding Information: 0 : BIND arg [<!DOCTYPE
html PUBLIC "-//W3C//DTD XHTML 1.0 Strict//EN"
"http://www.w3.org/TR/xhtml1/DTD/xhtml1-strict.dtd">] to paramete
[InputObject]
DEBUG: ParameterBinding Information: 0 : BIND arg
[<!DOCTYPE html PUBLIC "-//W3C//DTD XHTML 1.0 Strict//EN"
"http://www.w3.org/TR/xhtml1/DTD/xhtml1-strict.dtd">] to param
[InputObject] SUCCESSFUL
```

In fact, it appears to have accepted a couple of `String` objects from the pipeline. These look like header lines for an HTML file, which makes sense—`ConvertTo-HTML` probably gets these out of the way as boilerplate before it settles down to its real job.

Next, we see that the `MANDATORY` check on `Out-Null` succeeds, and we continue to deal with initial boilerplate issued by `ConvertTo-HTML`:

```
DEBUG: ParameterBinding Information: 0 : MANDATORY PARAMETER CHEC
on cmdlet [Out-Null]
DEBUG: ParameterBinding Information: 0 : BIND PIPELINE object to
parameters: [Out-Null]
DEBUG: ParameterBinding Information: 0 : PIPELINE object TYPE =
[System.String]
DEBUG: ParameterBinding Information: 0 : RESTORING pipeline
parameter's original values
DEBUG: ParameterBinding Information: 0 : Parameter
[InputObject] PIPELINE INPUT ValueFromPipeline NO COERCION
DEBUG: ParameterBinding Information: 0 : BIND arg [<html
>] to parameter [InputObject]
DEBUG: ParameterBinding Information: 0 :  BIND arg [<html
>] to param [InputObject]
SUCCESSFUL
```

OK, let's skip ahead a bit, past all the boilerplate "header" HTML. We'll go down to the point where `Get-Process` runs and where PowerShell recognizes the type of object it's produced:

```
DEBUG: ParameterBinding Information: 0 : BIND PIPELINE object to
parameters: [ConvertTo-Html]
DEBUG: ParameterBinding Information: 0 : PIPELINE object TYPE =
[System.Diagnostics.Process#HandleCount]
```

Next we'll see those `Process` objects being bound to the `–InputObject` parameter of `ConvertTo-HTML`:

```
DEBUG: ParameterBinding Information: 0 : Parameter [InputObject]
PIPELINE INPUT ValueFromPipeline NO COERCION
DEBUG: ParameterBinding Information: 0 : BIND arg
[System.Diagnostics.Process] to parameter [InputObject]
DEBUG: ParameterBinding Information: 0 : BIND arg
[System.Diagnostics.Process] to param [InputObject] SUCCESSFUL
```

The trace output goes on, of course, but this is what we were looking for: proof that PowerShell is doing what we expected. You'll notice the phrase `NO COERCION` quite a bit in the preceding; that's an indication that PowerShell was able to bind the output as is, without trying to convert it to something else. Coercion is one of the things that can make pipeline parameter binding

more confusing, and it's what this trace output can help you see and understand. For example, PowerShell is capable of *coercing*, or converting, a number into a string so that the resulting string can bind to a parameter that accepts `String`.

4.3.3 When ByValue fails

That was pretty indepth for ByValue, but what do we do when that fails? Go back to your paper diagram. Erase or cross out `ConvertTo-HTML` and `Out-Null`, and, in the second box, write `Stop-Service`. Don't run the resulting command yet—we need to talk about what happens.

You know that the first command produces `Process` objects. Examining its full help file, do you see any parameters of `Stop-Service` that will do both of the following?

- Accept pipeline input ByValue
- Also accept an input type of `Process`, `Object`, or `PSObject`

We don't see any parameters that fit the criteria, so the ByValue method fails. What do we do now?

4.4 ByPropertyName

You may notice one parameter of `Stop-Service` that accepts pipeline input ByProperty-Name: specifically, the `–Name` parameter. That parameter does accept ByValue, but we've moved past that—it's the ByPropertyName part that interests us now. Here's what it means: Because the *parameter* is spelled *N A M E*, PowerShell will look at the objects in the pipeline to see if they have a *property* spelled *N A M E*. If they do, PowerShell will take the values from the property and feed them to the parameter—*just because they're spelled the same*.

Try using `Trace-Command` to run `Get-Process | Stop-Service –whatif` (we included `–whatif` just to prevent any possibility of something going wrong). Can you see how PowerShell attempts to bind the object's `Name` property to the command's `–Name` parameter?

PowerShell will try to “pair” as many properties and parameters as it can. If the object in the pipeline has properties named `Name`, `ID`, `Description`, and `Status`, and the next command in the pipeline has parameters named `–Name` and `–Status`, then two of the object’s properties will bind to parameters (assuming that `–Name` and `–Status` were both programmed to accept pipeline input ByPropertyName). This can be a really useful technique. For example, suppose you have a CSV file named Users.csv that contains columns named samAccountName, Name, Title, Department, and City. Looking at the help file for `New-ADUser` (Get-Help Get-Aduser -Online) if you don’t have the command installed), what do you think would happen if you ran this?

```
Import-CSV Users.csv | New-ADUser
```

Give it some thought. If you have a test domain that you can play with, go ahead and create a CSV like that, and fill in a few rows’ worth of user information for made-up users that don’t exist. Run the command, and see if it does what you expect.

4.4.1 Let’s trace ByPropertyName

Let’s take another example of ByPropertyName binding and look at the portions of a trace where the binding happens. Here’s our command (we’re limiting `Get-Process` to retrieving processes whose names begin with the letter *O*, because we know we only have one such process, and it’ll make the output shorter):

```
PS C:\> trace-command -Expression { Get-Process -Name o* | Stop-J
➥ -PSHost -Name ParameterBinding
```

Let’s see what happens. First, we run through the parameter binding for `Get-Process`. This time, we do have a `NAMED` parameter: `-Name`, to which we’ve provided the value `o*`. There’s a problem, though, in that the parameter wants an *array* of strings—shown as `[string[]]` in its help file—and we’ve provided only one. PowerShell therefore creates an array, adds our `o*` to it, and attaches that one-item array to the parameter:

```
DEBUG: ParameterBinding Information: 0 : BIND NAMED cmd line args
[Get-Process]
DEBUG: ParameterBinding Information: 0 : BIND arg [o*] to paramet
```

```
[Name]
DEBUG: ParameterBinding Information: 0 : COERCE arg to [System.St
DEBUG: ParameterBinding Information: 0 : Trying to convert
argument value from System.String to System.String[]
DEBUG: ParameterBinding Information: 0 : ENCODING arg into collec
DEBUG: ParameterBinding Information: 0 : Binding collection param
argument type [String], parameter type
[System.String[]], collection type Array, element type [System.St
coerceElementType
DEBUG: ParameterBinding Information: 0 : Creating array with elem
[System.String] and 1 elements
DEBUG: ParameterBinding Information: 0 : Argument type String is
treating this as scalar
DEBUG: ParameterBinding Information: 0 : COERCE arg to System.Str
DEBUG: ParameterBinding Information: 0 : Parameter and arg types
no coercion is needed.
DEBUG: ParameterBinding Information: 0 : Adding scalar element of
String to array position 0
DEBUG: ParameterBinding Information: 0 : Executing VALIDATION met
[System.Management.Automation.ValidateNotNullOrEmptyAttribute]
DEBUG: ParameterBinding Information: 0 : BIND arg [System.String[
param [Name] SUCCESSFUL
```

Next is the usual check for `POSITIONAL` parameters, followed by a `MANDATORY` check:

```
DEBUG: ParameterBinding Information: 0 : BIND POSITIONAL cmd line
[Get-Process]
DEBUG: ParameterBinding Information: 0 : MANDATORY PARAMETER CHEC
cmdlet [Get-Process]
```

Now we start in on the `Stop-Job` command, handling `NAMED`, `POSITIONAL`, and `MANDATORY` again:

```
DEBUG: ParameterBinding Information: 0 : BIND NAMED cmd line args
[Stop-Job]
DEBUG: ParameterBinding Information: 0 : BIND POSITIONAL cmd line
[Stop-Job]
DEBUG: ParameterBinding Information: 0 : MANDATORY PARAMETER CHEC
cmdlet [Stop-Job]
```

PowerShell then gives each of the two commands a chance to run any `BEGIN` code that they may contain:

```
DEBUG: ParameterBinding Information: 0 : CALLING BeginProcessing
```

```
DEBUG: ParameterBinding Information: 0 : CALLING BeginProcessing
```

The only process returned, in our case, is one named `OSDUIHelper`, and it appears next in the trace output:

```
DEBUG: ParameterBinding Information: 0 : BIND arg
[System.Diagnostics.Process (OSDUIHelper)] to parameter [Job]
```

Let's see what PowerShell does with that, because we're pretty sure ByValue won't work:

```
DEBUG: ParameterBinding Information: 0 : Binding collection param
argument type [Process], parameter type
[System.Management.Automation.Job[]], collection type Array, elem
type [System.Management.Automation.Job], no coerceElementType
DEBUG: ParameterBinding Information: 0 : Creating array with elem
[System.Management.Automation.Job] and 1 elements
DEBUG: ParameterBinding Information: 0 : Argument type Process is
IList, treating this as scalar
DEBUG: ParameterBinding Information: 0 : BIND arg
[System.Diagnostics.Process (OSDUIHelper)] to param [Job] SKIPPED
```

That `SKIPPED` (which we've bolded in the output) is what tells us ByValue ultimately didn't work out. PowerShell tried! The `–Job` parameter of `Stop-Job` accepts input ByValue, so PowerShell gave it a shot. The parameter expects one or more objects of the type `Job`, so PowerShell created an array and added to it our `OSDUIHelper` object—which is of the type `Process`. But it couldn't do anything to make a `Process` into a `Job`, so it gave up. Time for plan B!

```
DEBUG: ParameterBinding Information: 0 : Parameter [Id] PIPELINE
INPUT ValueFromPipelineByPropertyName NO COERCION
DEBUG: ParameterBinding Information: 0 : BIND arg [5248] to param
DEBUG: ParameterBinding Information: 0 : Binding collection param
argument type [Int32], parameter type [System.Int32[]],
collection type Array, element type [System.Int32], no coerceElem
DEBUG: ParameterBinding Information: 0 : Creating array with elem
[System.Int32] and 1 elements
DEBUG: ParameterBinding Information: 0 : Argument type Int32 is n
treating this as scalar
DEBUG: ParameterBinding Information: 0 : Adding scalar element of
Int32 to array position 0
DEBUG: ParameterBinding Information: 0 : Executing VALIDATION met
[System.Management.Automation.ValidateNotNullOrEmptyAttribute]
```

```
DEBUG: ParameterBinding Information: 0 : BIND arg [System.Int32[]
[Id] SUCCESSFUL
DEBUG: ParameterBinding Information: 0 : MANDATORY PARAMETER CHEC
cmdlet [Stop-Job]
```

The `Process` object has an ID property, and the `–Id` parameter of `Stop-Job` accepts pipeline input ByPropertyName. The property contains, and the parameter accepts, an integer, although the parameter wants an array of them. So, PowerShell creates a single-item array, adds our ID of 5248 to it, and attaches it to `–Id`. And it works! Well, sort of. We know, and you've probably guessed, that `Stop-Job` is expecting the ID number of a *job*, whereas we're providing the ID number of a *process*. Not quite the same thing. It's like trying to use your house number as a phone number: They're both numbers, but they refer to different kinds of entities. That's why we eventually get an error:

```
Stop-Job : The command cannot find a job with the job ID 5248. Ve
the value of the Id parameter and then try the command again.
At line:1 char:52
+ trace-command -Expression { Get-Process -Name o* | Stop-Job } -
+ CategoryInfo : ObjectNotFound: (5248:Int32) [Stop-Job],
PSArgumentException
+ FullyQualifiedErrorId : JobWithSpecifiedSessionNotFound,Microso
PowerShell.Commands.StopJobCommand
```

The trace output, should you care to try this on your own (and you should!), shows PowerShell attempting to construct the error message record that eventually appears onscreen, which is a fairly arduous process that involves a few dozen more lines of trace output. `Trace-Command` can be a handy cmdlet for troubleshooting, so take the time to read the full help and examples.

4.4.2 When ByPropertyName fails

What if you get into a situation where you have an object in the pipeline and a command ready to receive it, but neither ByValue nor ByPropertyName works? It's entirely possible—the command may not be able to do anything with the type of object in the pipeline, for example, or may not accept pipeline input at all. This should be rare, and we created a simple PowerShell command to demonstrate:

```
PS C:\> "frances" | set-foo
set-foo : The input object cannot be bound to any parameters for
command either because the command does not take
pipeline input or the input and its properties do not match any o
parameters that take pipeline input.
At line:1 char:13
+ "frances" | set-foo
+             ~~~~~~~
    + CategoryInfo          : InvalidArgument: (frances:String) [
ParameterBindingException
    + FullyQualifiedErrorId : InputObjectNotBound,Set-Foo
```

As you can see, the entire pipeline will fail. Because the objects *can't* be passed into the command, and because PowerShell doesn't want to just discard the pipeline objects, it'll throw an error message and quit running.

4.4.3 Planning ahead

When you start designing your tools, which most likely will take advantage of some form of parameter binding, we want you to keep a few ideas in mind. First, you should have only one parameter designated to accept pipeline input by value. If you think about it, this makes sense. Suppose your command had two parameters, -Foo and -Bar, and they both were designed to accept input by value. If you ran the command like this

```
Get-content data.txt | get-magic
```

would the incoming values go to `-Foo` or `-Bar`? PowerShell has no way of knowing. This means only one parameter should take input by value. Technically, you can have multiple parameters designed to take input by value, but only if you use parameter sets, which isn't something you're likely to get into right away.

But you can have as many parameters as you want designated to take input by property name. You can even have one parameter accept input by value *and* property name. You'll discover that this is as much of an art as anything. Our best recommendation is to think about likely usage patterns for the tools you're creating. Will someone most likely pipe the results of a command to your command? Or will they run it as the initial command in a pipeline expression? Of course, you'll want to test different usage patterns to verify

that your parameter binding is working as expected. If not, turn to `Trace-Command` to get a better idea about what is happening inside the pipeline.

4.5 Summary

Our goal with this chapter—and we hope we've achieved it—was twofold. First, we wanted you to get a fresh understanding of how pipeline objects move from command to command. We also wanted you to understand how useful command tracing can be in visualizing that process and in diagnosing unexpected pipeline behavior. Before long, you're going to be designing your own commands that will accept pipeline input, and we want you to continually think about this process, and how it works, as you do so.

5 Scripting language: A crash course

In this book you wlll notice that you are not given general information with out putting it to use right away. In this case, though, I’m going to make an exception. You'll be writing scripts in this through this book, and that means including a certain amount of code. PowerShell's scripting language is super-simple, containing a few dozen actual keywords, and we're only going to use about a dozen in this book. But I need to get the most important of those into your head so that I can use them at will when the time comes. The goal of this chapter is not to provide complete coverage of these items but to give you a quick introduction. When you see them in use throughout the rest of the book, they'll begin to make more sense.

Tip

To learn even more about the material in this chapter, the first place to look is PowerShell's help system. Much of this is documented in `about` topics. You can try looking at things like `about_if` and `about_comparison_operators`. Or grab a copy of *PowerShell in Depth* (Manning, 2013, www.manning.com/books/poIrshell-in-depth).

5.1 Comparisons

Almost all of the scripting bits I’m going to introduce in this chapter rely on *comparisons*. That is, you give them some statement that must evaluate to either True or False, and the scripting constructs base their behavior on that result. In order to make a comparison in PoIrShell, you use a *comparison operator*. Unlike traditional scripting or programming languates PoIrShell doesn’t use the traditional operatior characters (<>+=-) but instead PoIrShell uses an English arriviation. Here are the core ones that you will likely use through this book:

- `-eq`—Equal to
- `-ne`—Not equal to
- `-gt`—Greater than
- `-ge`—Greater than or equal to
- `-lt`—Less than
- `-le`—Less than or equal to

For string comparisons, these are case-insensitive by default, which means "Hello" and "HELLO" are the same. If you explicitly need a case-sensitive comparison, add a `c` to the front of the operator name, as in `–ceq` or `–cne`.

When you use these operators, PoIrShell will return a True/False value:

```
PS C:\> 1 -eq 1
True
PS C:\> 5 -gt 10
False
PS C:\> ‘James’ -eq ‘Jim’
False
PS C:\> ‘James’ -eq 'james'
True
PS C:\> 'james' -ceq ‘James’
False
```

PoIrShell doesn't have the same extensive range of operators as some languages. For example, there's no "exactly equal to" comparison that forbids the shell's parser from coercing a data type into another type.

TRY IT NOW

Is `5 -eq “Five”` True or False?

5.1.1 Wildcards

There's a wildcard comparison: `-like` and `–notlike`, along with the case-sensitive versions `–clike` and `–cnotlike`. These let you use common wildcard characters like `*` (zero or more characters) and `?` (a single character) in making string comparisons:

```
PS C:\> 'james' -eq ‘jim’
```

```
False
PS C:\> 'james' -eq 'James'
True
PS C:\> 'james' -ceq 'James'
False
PS C:\> 'PoIrShell'-like '*shell'
True
PS C:\> 'james' -notlike 'james*'
False
PS C:\> 'james' -like 'jam?s'
True
PS C:\> 'james' -like 'J?m'
False
```

These wildcards aren't as rich as the full regular-expression language; PoIrShell does support regular expressions through its `–match` operator, although I won't be diving into that one in this book. Check out the chapter on PoIrShell and regular expressions in *PoIrShell in Depth*.

5.1.2 Collections

PoIrShell's `–contains` and `–in` operators operate against collections of objects. They get a little tricky, and people almost always confuse them with wildcard operators. For example, I see this a lot:

```
If ("DC" –in $ServerList) {
  $IsDomainController = $True
}
```

This doesn't work the way you might think. It reads just fine in English, but it's not what the operator does. If you start with an array, you can use these operators to determine whether the array (or collection) contains a particular object:

```
$array = @("one","two","three")
$array –contains "one"
$array –contains "five"
"two" –in $array
"bob" –in $array
```

TRY IT NOW

Go ahead and run those five lines of code in PoIrShell, typing the lines one at a time and pressing Enter after each.

5.1.3 Troubleshooting comparisons

About 50% of the script bugs are due to a comparison that isn't working the way you expect. Our best advice for troubleshooting these is to stop working on your script, jump into the PoIrShell console, and try the comparison there.

TRY IT NOW

What will "55" –eq 55 I're not going to give you the ansIr—try it, and see if you can explain to yourself why it did what it did.

5.2 The If construct

You'll often find the need to use an `If` construct, which allows your code to make logical decisions. In its full form, this construct looks like this:

```
If (<expression>) {
    # code
} ElseIf (<expression>) {
    # code
} ElseIf (<expression>) {
    # code
} Else {
    # code
}
```

Here's what you need to know:

- An *<expression>* is any PoIrShell expression that will result in either `$True` or `$False`. For example, `$something -eq 5` will be `$True` if the variable `$something` equals 5. Read PoIrShell's `about_comparison_operators` for a list of valid comparison operators, including `-eq`, `-ne`, `-gt`, `-like`, and so on.
- The expressions in your `If` statement can be as complicated as they need to be. Just remember that the entire expression has to result in True in order for the script block code to execute:

```
$now = Get-Date
if ($now.DayOfIek -eq 'Monday' -AND $now.hour -gt 18) {
  #do something
}
```

- The `If` portion of the construct is mandatory, and it must be folloId by a `{script block}` that will execute if the expression is True.
- You may have zero or more `ElseIf` sections. These sections supply their own expression and script block, which will execute if the expression is True. But there's an important point you must remember: Only the script block of the first expression that is True will run. So, in the previous skeleton example, if the first expression is True, then only the first script block will run; none of the `ElseIf` expressions will even be evaluated. If you have multiple `ElseIf` statements, PoIr-Shell will continue to evaluate them until it finds one that's True. When it does, PoIrShell will jump to the command after the `If` structure.
- You may have an optional `Else` section at the end. This defines a script block that will execute if no preceding expression evaluated to True.
- There is no End If statement like you might find in other languages.
- In the previous skeleton example, you'll notice lines that start with a `#` symbol. Those are comments—PoIrShell will ignore everything after a `#` to the end of that line.

PoIrShell is pretty forgiving about the formatting of these things. For example, I think this is a nice way to format the construct:

```
If (<expression>) {
    # code
} ElseIf (<expression>) {
    # code
} ElseIf (<expression>) {
    # code
} Else {
    # code
}
```

Some people like to put the opening `{` on a separate line. I’m not saying which one is the correct way but I wanted you to be aware that some people may do it this way:

```
If (<expression>)
```

```
{
    # code
}
```

But PoIrShell will let you do stuff like this as Ill:

```
If (<expression>) { # code }
ElseIf (<expression>) { # code }
ElseIf (<expression>) { # code }
Else { # code }
```

I think that's harder to read, especially if any of the script blocks need to contain multiple lines of code. I certainly don't recommend you using this—but you'll see other people do so sometimes. The bottom line is that PoIrShell doesn't care, but you should. Pick a formatting style that makes your code easy to read, and stick with it.

Quick Tip

Code formatting is important. It may seem like an irrelevant aesthetic detail, but it makes your code easier to follow, and "easier to follow" means "feIr bugs." Trust us. Take a travesty like this:

```
If ($user) { ForEach ($u in $user) {
Set-ADUser –Identity $user –Pass $True }
```

It's hard to tell if that's valid code or not (it isn't), given how the curly braces are mangled and the way the `ForEach` starts on the same line as the `If`.

If you're using a good editor, like VS Code, then it's pretty easy to keep your code neat. Basically, just let the editor do its thing. When you open a construct with `{` and press Enter, VS Code will automatically add the closing `}` and place your cursor—indented a perfect four spaces—inside the construct. Focus on letting VS Code do the work—use the Tab key when you need to indent a line, for example, rather than pressing the spacebar.

Also if you haven’t already turn on bracket colorization in VS Code.

If things aren't lining up vertically, here's a trick: Highlight the affected

region (or your entire script document), right-click, and select Format Selection. VS Code will "clean up," properly indenting within each construct.

You can also open the command palate and `Format Document` which will format the entire document for you.

Let's look at a practical example of this construct. Suppose you have a `Process` object in the variable `$proc`, and you want to take some action if the process's virtual memory (VM) property exceeds a certain predetermined value:

```
If ($proc.vm –gt 4) {
  # take some action
}
```

Notice that I've used a comment—remember, anything after a # symbol is ignored, until the end of that line—to indicate where the action-taking code would go. What if, instead, you wanted to take an action for VM values less than 2 but greater than 4?

```
If ($proc.vm –gt 4 –or $proc.vm –lt 2) {
  # take some action
}
```

The `-or` Boolean operator lets you "connect" two conditions. There's an important point to make here: The comparison on either side of an `-or` or an `-and` must be a *complete* comparison. This, for example, wouldn't work:

```
If ($proc.vm –gt 4 –or –lt 2) {
  # take some action
}
```

In this "wrong" example, the "less than" comparison isn't complete. It doesn't have anything on the left side; PoIrShell will ask, "What, exactly, is supposed to be less than 2?" and will toss an error. If it helps, you can use parentheses to visually set off each comparison:

```
If ( ($proc.vm –gt 4) –or ($proc.vm –lt 2) ) {
  # take some action
}
```

Let’s look at an example that has additional options:

```
If ($proc.vm –gt 4) {
  # take some action
} ElseIf ($proc.vm –lt 2) {
  # take some other action
} Else {
  # nothing was true; do this instead
}
```

As I explained earlier, PoIrShell will perform the first of these actions whose condition evaluates to True and then stop evaluating anything after that.

5.3 The ForEach construct

You'll often use a `ForEach` construct, which is sometimes referred to as an *enumerator*. ForEach is used in most programming languages and it will look familiar. It works a bit like PoIrShell's `ForEach-Object` command, but it has a different syntax:

```
ForEach ($item in $collection) {
    # code to run for each object referenced at $item
}
```

The idea here is to take a collection or an array of objects and go through them one at a time. Each object, in its turn, is placed into a separate variable so that you can refer to it easily. After you've enumerated all the objects in the collection or array, the loop exits automatically and the rest of your script executes.

The second variable in the construct, `$collection`, is expected to contain zero or more items. The `ForEach` *loop* will execute its `{script block}` one time *for each* item that is contained in the second variable. So, if you provided three computer names in `$collection`, the `ForEach` loop would run three times. Each time the loop runs, one item is taken from the second variable and placed into the first. So, within the previous script block, `$item` will contain one thing at a time from `$collection`.

Tip

The variable names `$item` and `$collection` are ones I made up. You'd ordinarily use different variable names that correspond to what those variables are expected to contain.

You'll often see people use singular and plural words in their `ForEach` loops:

```
$names = Get-Content names.txt
ForEach ($name in $names) {
    # code for each $name
}
```

This approach makes it easier to remember that `$name` contains one thing from `$names`, but that's purely for human readability. PoIrShell doesn't magically know that *name* is the singular of *names*, and it doesn't care. The previous example could easily be rewritten as

```
$names = Get-Content names.txt
ForEach ($purple in $unicorns) {
    # code
}
```

PoIrShell would be perfectly happy. That code would be a lot harder to read and keep track of, but hey, if you like unicorns, go for it. In some cases, though, you'll notice that the second variable is *not* plural, although it feels like it should be:

```
foreach ($computer in $computername) {
```

It's often because `$ComputerName` is one of a function's input parameters. PoIrShell's convention is to use singular words for command and parameter names. You won't see `-ComputerNames`; you'll only see `-ComputerName` as a parameter. You want to stick with the convention, so in that case your `ForEach` loop wouldn't follow a singular/plural pattern. Again, PoIrShell itself doesn't care, and I feel it's more important that your outward-facing elements—command and parameter names—follow PoIrShell naming conventions.

BEST PRACTICE

In a script, I greatly prefer the use of `ForEach` over the `ForEach-Object`

command. There are a number of advantages: You get to name your single-item variable rather than using `$_` or `$PSItem`, making your code more readable; the construct often executes more quickly than the command over large collections, too. But with large collections of arrays, the construct can force you to use more memory, because the entire array or collection must be in a single variable to start with. When you use the command, objects can be piped in one at a time and dealt with, consuming less memory in some scenarios.

There's one *gotcha* with the `ForEach` construct: It doesn't write to the pipeline after the closing curly brace. I've seen people try to create something like this:

```
$numbers=1..10
foreach ($n in $numbers) {
 $n*3
} | out-file data.txt
```

only to have it fail. If you try this in the PoIrShell ISE or other code editors, you'll most likely see an error about an empty pipe. Everything *inside* the script block writes to the pipeline. You just can't pipe anything *after*. But you can write the code like this:

```
$numbers=1..10
$data = foreach ($n in $numbers) {
 $n*3
}
$data | out-file data.txt
```

This will work as expected. In this second example, `$n*3` is implicitly writing its output to the pipeline (`Write-Output` is PoIrShell's default command), and the end result of the `ForEach` construct is being captured to the `$data` variable. That, in turn, is then piped to `Out-File`. Honestly, much of this confusion happens because the alias for the `ForEach-Object` is `ForEach`, although it works differently than the `ForEach` *construct*. The construct, which is what I're teaching here, always has the `($x in $y)` syntax right after it, whereas the `ForEach-Object` command doesn't use that syntax.

With all this in mind, I urge you to think carefully about when to use the `ForEach` enumerator, because it's easy to fall into a non-PoIrShell habit. I've

seen code like this from people just getting started or who clearly haven't grasped the PoIrShell model:

```
$services = Get-Service –name bits,lanmanserver,spooler
Foreach ($service in $services) {
  Restart-service $service –passthru
}
```

This will obviously work if you care to try, and it's what I did in the days of VBScript. But this isn't the PoIrShell way. There's no need for such contorted code when this works just as Ill:

```
$services | restart-service -passthru
```

5.4 The Switch construct

This construct is great as a replacement for a huge `If` block that contains multiple `ElseIf` sections. Here’s a prototype:

```
switch (<expression>) {
  <condition> { <script block> }
  <condition > { <script block> }
  <condition > { <script block> }
  default { <script block {
}
```

Here's how it works:

1. The expression is usually a variable containing *a single value or object*. This is important, because `switch` alone won't enumerate collections or arrays.
2. Each condition is a value that you think the expression might contain. Each condition is folloId by a script block (which can be broken into multiple lines); and if the expression contains the condition, then the associated script block will execute.
3. The `default` block executes if no conditions match; you can omit `default` if you don't need it.

Each matching condition will execute. It's possible to have multiple matches; if so, each matching script block will execute. This may seem nonsensical

until you dive into some of the construct's advanced options:

```
$x = "d1234"
switch -wildcard ($x)
    {
        "*1*" {"Contains 1"}
        "*5*" {"Contains 5"}
       "d*" {"Starts with 'd'"}
        default {"No matches"}
    }
```

The `-wildcard` switch makes it possible for multiple conditions to match. For example, in this example, if `$x` contained "1 of 5 dying worms", then you'd get two lines of output: "Contains 1" and "Contains 5". The third pattern doesn't match; and because at least one pattern did match, the `default` block won't execute. Be sure to read `about_switch`.

5.5 The Do/While construct

You'll be using this guy later on, as Ill. Basically, `While` lets you specify a script block of statements, which will execute *while* some condition is true. You get two basic variations:

```
While (<condition>) {
 # code
}
Do {
 # code
} While (<condition>)
```

These both do essentially the same thing: They repeat the code inside the construct until the specified `<condition>` is no longer true. Here's the difference:

- With the first version, the code inside the construct *might not ever run.* It will only run if the `<condition>` is true to begin with.
- With the second version, the code inside the construct *will always run at least once.* That's because it doesn't check the `<condition>` until after the first execution.

You need to be a bit careful about writing these loops, because there's no automatic exit the way there is with a `Switch`, `If`, or `ForEach` construct. That is, unless you're sure that your `<condition>` will eventually change and evaluate to false, then a `Do/While` construct can basically loop forever—something called an *infinite loop*. In most PoIrShell hosts, like the console, you can press Ctrl-C to break out of the loop if you realize you've created an infinite one.

5.6 The For construct

Here's the last of the scripting constructs, although this is one it's probably safe to skip if your head is starting to feel full. I use this so rarely that I debated even putting it in the book, but then I figured somebody would be upset that I left out this one poor li'l construct, and I don't want to hurt anyone's feelings. It typically looks like this:

```
For (<start>; <condition>; <action>) {
  # code
}
```

This loop is meant to repeat the code inside the construct *a certain number of times*. It can be a bit easier to explain with a more concrete example:

```
For ($i = 0; $i –lt 3; $i++) {
  Write $i
}
```

The idea is that the `<start>` item gets executed before the construct runs, in this case setting `$i` to a value of 0. The `<condition>` keeps the construct running as long as it evaluates to true. Finally, each time *after* the construct's script block executes, the `<action>` is performed. So, in this example, the script will execute four times:

1. `$i` is initially set to 0, and then the script block executes.
2. Because `$i` is less than 3, `$i` is incremented by 1, and the script block executes.
3. Because `$i` is less than 3, `$i` is incremented by 1 (it's now 2), and the script block executes.
4. Because `$i` is less than 3, `$i` is incremented by 1 (it's now 3), and the

script block executes.
5. Now, `$i` is 3, which isn't less than 3, and so the script block doesn't execute and the construct exits.

This isn't terribly different from using PoIrShell's range operator and a `ForEach-Object` command:

```
0..3 | ForEach-Object { Write $_ }
```

The `For` construct is easier to read and feels more declarative, to us, and if I ever needed to perform that kind of task, I'd probably opt for the construct over the range-operator trick. But the reason I so rarely use `For` is that I don't run into a lot of situations where I need to do something a set number of times. I tend to find ourselves using `ForEach` more often, because I've got a collection of objects and want to perform some operation against each one. To be fair, you can do that with `For` as Ill—but it's a bit ugly. Assuming `$objects` contains a collection of objects, here are two ways you could enumerate them:

```
For ($i = 0; $i –lt $objects.Count; $i++) {
  Write $objects[$i]
}
ForEach ($thing in $objects) {
  Write $thing
}
```

I definitely think the second example is easier to read. I suspect that people using the first technique are coming to PoIrShell from a language that doesn't have an enumeration construct like `ForEach`, and they default to `For` because it's what they know.

5.7 Break

There's one more scripting critter you should know about: the `Break` keyword. It exits whatever it's in—with some caveats:

- In a `For`, `ForEach`, `While`, or `Switch` construct, `Break` will immediately exit that construct.
- In a script, but outside of a construct, `Break` will exit the script.

- In an `If` construct, `Break` won't exit the construct. Instead, `Break` will exit whatever *contains* the `If` construct—either an outer `For`, `ForEach`, `While`, or `Switch`, or the script itself. Basically, the `If` is invisible to `Break`, and so whatever the `If` is within is what `Break` sees.

Break is useful for aborting an operation. For example, suppose you have a list of computers in the variable `$computers`. You want to go through each one, pinging them to see if they respond. But should one computer not respond to its ping, for whatever reason, you want to immediately stop everything and quit. You might write this:

```
ForEach ($comp in $computers) {
  If (-not (Test-Ping $comp –quiet)) {
    Break
  }
}
```

There's a bit of an antipattern that you need to be aware of. Some folks will write a loop that's intentionally infinite. Instead of specifying a condition to end the loop naturally, they'll use `Break` to abort. Here's a short example:

```
While ($true) {
  $choice = Read-Host "Enter a number"
  If ($choice –eq 0) { break }
}
```

Often, I wonder if those folks just Iren't aware of the loop's other options. In this case, for example, it seems as if they wanted to ensure that the loop's contents executed at least once, but they didn't know how to go into the loop the first time. I'd rewrite this as follows:

```
Do {
  $choice = Read-Host "Enter a number"
} While ($choice –ne 0)
```

This is a little cleaner in terms of code execution. A problem with `Break` is that it provides an alternate way out of a construct, creating a secondary flow of logic that's harder to follow. Because `Break` is often used inside an `If` construct—as I've shown here—it becomes difficult to predict the behavior of the script without running it. That, in turn, creates all kinds of debugging and troubleshooting problems that I feel are best avoided. Short story: I try to

write constructs that have a meaningful natural end point, and I try to avoid `Break` when I can.

TIP

I try to avoid using `Break` when I can. `Break` creates what I call a *non-natural* exit to a loop. That is, the loop isn't coming to its natural conclusion. Especially in a loop that contains a lot of code, it's easy to skim through it and miss the `Break` keyword, making it harder to understand why the loop is bailing out prematurely. When I *do* have to use `Break`, I make sure to surround its use with some blank lines and clearly worded comments that indicate what's happening.

5.8 Summary

The constructs I covered in this chapter form the core of what I consider to be PoIrShell's *scripting language*. That is, unlike commands, these constructs exist to provide logic and structure to your scripts. If you can keep these four core constructs in mind, you'll probably find that they're all the scripting code you need to know for most of the scripts you'll write.

6 The many forms of scripting (and which to choose)

You probably think you are the victim of bait-and-and-switch tactics by Manning. We keep using words such as *tool* and *toolmaking* but haven’t talked much about scripting. After all, the title of this book is *Learn PowerShell Scripting in a Month of Lunches*. But what if I told you that scripting -eq toolmaking in this instance? You see, *scripting* is a pretty generic word, and in the PowerShell universe, we feel that it can refer to a couple of specific and valuable things that we will go over in this chapter.

6.1 Tools vs. Controllers

Think about a hammer. A hammer is a tool, and it’s probably one you’ve at least seen before, even if you’ve never wielded one. A hammer is a self-contained thing; it only does one thing: Strike other things. A hammer has no context about its life and no clue about its destiny. A hammer may be used one day to help build a house, another day to break a window, and another day to smash your thumb. Sitting alone in a toolbox, a hammer is useless unless someone is swinging it.

You are the one that is going to swing the happier to strike the nail (or your thumb). Think of the hammer for a second again. You have to think about how hard you will swing it and what you will hit (be it a nail, window, or your thumb). The desired output is to hit the nail and drive it into the wood, and it will produce an audible ping as the nail head is struck. But what happens if you hit the nail at an angle? It will bend or break, having unattended consequences.

What if I told you PowerShell is just like a hammer. It takes input from you and produces output. Sometimes it works the way you want it to, and sometimes it doesn’t, but PowerShell will always do **EXACTLY** what you tell it to do. Nothing more and nothing less. This is the beauty of PowerShell,

in my opinion. What PowerShell calls a *command*—a catchall word referring to cmdlets, functions, and other executable artifacts—we call a *tool*. A tool should do one thing and one thing only. That’s why we have tools named `Get-Process`, `Start-Process`, `Stop-Process`, and so on—each of them does one thing and one thing only. We don’t have a tool called “Manage-Processes,” capable of starting, stopping, or listing processes depending on your parameters. Such a super-tool goes against the PowerShell ethos of single-task-ed-ness.

Think about `Stop-Process`. What good is it? No good at all, really, on its own. Like a hammer, it needs to be given context and purpose. It needs to be controlled. When used as part of a *controller script*, the tool gains meaning and purpose.

This chapter is about learning to draw the line between these two equally important kinds of script. There are specific techniques suitable for tools and different ones ideal for controllers. Each set of techniques is designed to reduce your workload, reduce debugging, reduce maintenance, and increase readability and reusability. Knowing which kind of script you’re writing will help direct you to the right set of techniques, and that’s the key to being a successful scripter and, ultimately, toolmaker!

6.2 Thinking about tools

Tools have some important characteristics in the PowerShell world:

- *Tools do one thing*, which should be described by the verb portion of their name. It’s better to make five small tools that each do one thing than to make one big tool that does five things. Smaller, more tightly scoped tools are easier to write, easier to test, and easier to debug and maintain.
- *Tools don’t know where their input data is generated*, any more than a hammer knows in advance whether it will be held in a hand or duct-taped to some robotic contraption. Tools accept all input only from their parameters, just as a hammer accepts input only from what’s holding its handle. (Yeah, we’re playing pretty loose with the metaphor, but you get the idea.) *Other* tools may be used to create the input that’s then fed to a

tool's parameters.

- *Tools don't know how their output will be used*, and they don't care, any more than a hammer cares if it will be hitting a nail or a thumb. Tools don't worry about making their output pretty—*other* tools can handle that. Tools don't worry about where their output will go—again, *other* tools can handle that.

We tend to informally think about several different types of tools. This isn't a strict taxonomy, but it does give you an idea of how they can relate to one another:

- *Input tools* are designed to create data that will primarily be consumed by other tools. You might write a tool that gets a bunch of computer names from Azure Active Directory for example. *Get* is a common verb for input tool names, but you'll also see *Import* and *ConvertFrom*.
- *Action tools* usually require some additional input before they do something—and that "something" can be anything you imagine. Plenty of commands have verbs like *Set* and *Remove*.
- *Output tools* are usually designed to take the output of an input tool or an action tool, and render it for some specific purpose. They might create a specially formatted data file, render a particular kind of onscreen display, and so on. Verbs like *Out*, *Format*, *ConvertTo*, and *Export* are common for output tools.

Image that you need to write a script that will report the password age of all the service accounts in your environment, format that into a CSV so the SIEM tool used by your Cybersecurity department can parse logs to see where these accounts are being used. And Upper Management wants a nice HTML report to display on their video board during the daily Operations Brief. How many tools do you need to write? You have to start by thinking of the discrete tasks involved, and see what tasks are already solved by a PowerShell tool:

- First we need find the command that will get the account password age, in this case Get-AdUser is what we want to use. We will grab some of the attributes, and save that as an array, export it to a CSV then do some fun HTML manipulation as well.
- We will need to figure out how to filter based on password age.

Fortunately, the native `Where-Object` command can do that, so you have to write a fancy widget to filter this.

- You'll need to convert those results to CSV and save to a file, and the native `Export-CSV` command can do that for you—no work for you, here!
- You'll also need a way to make an HTML report. If the native `ConvertTo-HTML` command isn't sufficient, then the EnhancedHTML2 module from the PowerShellGallery includes `ConvertTo-EnhancedHTML`, which should do the trick. You'll need to learn to use it, but you won't have to code anything.

So, for all of that, you only need to write *one tool*. That's the beauty of the tool-based approach: So many great, generic tools already exist in PowerShell, and out in the broader world, that you often only need to focus on the stuff that's entirely specific to your environment. Do that the right way, and your custom tools will connect seamlessly to everything that already exists.

But your prospective Get-ServiceAccountPassword tool is useless by itself. It needs to be given purpose and a context. It needs a controller.

Note

We should point out that you may not find the terms *tool* and *controller* in Microsoft documentation or even in the greater PowerShell community. For many people, it's just *scripting*. But in order to truly understand the PowerShell way of automating things, you should keep the concepts of *tool* and *controller* in mind. We've seen many beginning students struggle with writing reusable PowerShell code because they're trying to do everything at once. Defining the tool separately from how it will be used is very important.

6.3 Thinking about controllers

Whereas tools are generic and lack context, controllers are all about context. The purpose of a controller is to put a tool to a specific use, in a specific kind of situation. This is a good thing for you because a tool you create can be used in many different scenarios, which is what the controller is all about. We

don’t use command-style, verb-noun names for controllers; we give them friendlier, more English-like names. For example, PasswordHistoryReport.ps1 is the script we might create to generate that HTML report of customers who’ve been inactive for a year or more. That script might be really simple, containing only a single pipeline:

```
Get-ServiceAccountPassword |
Where-Object { $_.passwordlength –lt (Get-Date).AddDays(-365) } |
ConvertTo-HTML |
Out-File \\intranet\www\reports\inactive-customers.html
```

It’s not a complex script, and that’s the idea. Controllers often *are* simple, because they’re just stringing together some tools. None of these tools knew beforehand that they’d be involved in creating HTML customer reports, but this controller gave them purpose. We’d probably have another one, PasswordHistoryReportCSVDataFile.ps1, that would take care of generating the required CSV data file. Just for fun, we might also create DisplayPasswordHistoryReport.ps1, which would query inactive customers and format the output for an attractive onscreen display. It never hurts to go above and beyond!

Like tools, controllers have some specific characteristics:

- *A controller is tied to a context.* It automates a business process, interacts with a human being, or does some other situation-specific thing.
- *A controller often has hardcoded data*, such as a filename that will be read as input or a database connection string that will give output a place to go.
- *A controller is responsible for putting its output into a particular form*, which may not be structured data. For example, a controller may display information onscreen or send it to a printer. The tool just writes objects to the pipeline.
- Whereas a tool *performs a task*, a controller *solves a problem*. That “problem” is often a business need or management directive.

People often ask about writing “graphical scripts” in PowerShell, using either .NET Framework’s Windows Forms library or its newer Windows Presentation Framework (WPF) library. You can do it, and we consider such

scripts to be *controllers*. They should contain minimal code and mainly rely on running tools. The PowerShell paradigm is that the commands that are executed from a graphical controller are the same commands you could run from an interactive console prompt. The graphical scripts merely put those tools to a specific purpose, tied to the eyes and fingers of human beings.

Controllers from commands

If you look at the previous sample controller script that uses our fictitious Get-ServiceAccountPassword tool, it’s just a PowerShell command. Your “controller” can be you typing a command interactively in the console. This is a great way to make sure your tool does what you intend.

Putting the commands in a controller script saves a ton of typing and makes running your command consistent. A controller script can also be a bit more complex if you need it to be. And by using a script file, anyone can run it, and the results will be consistent and predictable.

6.4 Comparing tools and controllers

Think about an automotive assembly line. These days, they’re largely staffed by specialized robots. One robot paints the car; another one welds two pieces together. Those robots are tools: In a warehouse all by themselves, they’re useless. It’s when you add a controller—the production line, which places the robots in sequence and coordinates their activities—that you have something useful. Table 6.1 outlines some of the key differences.

Table 6.1 Tools vs. controllers

Tools	Controllers
Do one thing and one thing only.	Connect multiple tools.

Accept input on parameters.	May have hardcoded input, and may use tools to retrieve data that will be fed to other tools.
Produce data as objects.	May produce any kind of output, including formatted data, special files, and so on.
Complete a task.	Solve a problem or meet a need.
Are often useless or minimally useful on their own.	Are self-contained.
Are useable across a variety of situations.	Are used only for a specific situation.

In this book, we'll be focusing a great deal on creating tools. How they're used is no different than using any other PowerShell command like `Get-Eventlog`. Anyone who has access to your tools can create their own controller.

6.5 Some concrete examples

Let's walk through some real-world examples of this "tools versus controllers" design concept. Notice that you will see little code in these examples but instead we will be walking through the though process behind it.

6.5.1 Emailing users whose passwords are about to expire

This is a great example, and it's one we're going to put some code to later in this book. Say that you wanted to send a quick email reminder to users whose

passwords were about to expire in a day or two. What's involved there?

You'd need to start by getting a list of users who *have* expiring passwords—that is, whose accounts aren't disabled and who don't have a "password does not expire" setting. You'd probably then need to calculate exactly when their password does expire, and filter out anyone whose password wasn't expiring within whatever range you cared about. You'd then send them all an email and perhaps log that information to a file for diagnostic purposes.

You'd basically have five distinct tools you'd need to build, each one performing a single *task* from that overall *process*:

- Get non-expiring user accounts.
- Get password expiration date.
- Filter accounts based on number of days.
- Send email.
- Create audit trail.

If you did it right, your "controller" script might look like this:

```
Get-EnabledNonExpiringUser |
Add-ExpiryDataToUser |
Where-Object { $_.DaysToExpire –lt 2 } |
Send-PasswordExpiryMessageToUser |
Export-CSV report.csv
```

Three of those are new tools that you'd need to build, and two of them are native to PowerShell. You'd maybe be looking at writing a hundred or so lines of code to build those three tools—and some of them would have uses in other business processes. For example, getting enabled, non-expiring user accounts could be useful elsewhere. Getting a list of all users and adding password expiration data to them could also be useful in other scenarios. Modularizing these tasks as *tools*, and then calling them from a *controller*, makes a lot of sense. And remember, the controller doesn't necessarily have to be a script. It could be you running the commands in a PowerShell session. Using a script saves typing and ensures consistency.

6.5.2 Provisioning new users

This is our classic "tools versus controllers" example. Think about what goes into provisioning a new user in your organization. You probably have to set up an account, mailbox-enable it, set up a home folder somewhere, maybe add them to something in SharePoint, and so on. Each of those is obviously a discrete task within the process, and each of those tasks should be a tool. Many of those tools—like `New-ADUser`—are provided by Microsoft.

There's an opportunity to be clever here, too. For example, *where* do you set up the new home folder? What's your normal business logic? "Well, we look at the existing file servers, and we usually don't put more than 1,000 users per home folder file server. So we find a server with less than 1,000 home folders already, and use that one. But if the server we pick has less than 75 GB free, then we leave it alone and pick another one." That's a *task*, and it's one you could automate. Perhaps you'd create a Select-UserHomeFolderFileServer tool that does all the analysis and returns a list of eligible servers, and then a New-UserHomeFolder tool that uses the first eligible server to create the new user's home folder on. Those are two discrete tasks and should be two discrete tools.

Let the verb be your guide

We had a need, once, to grab a bunch of users from Active Directory. `Get-ADUser` does that just fine, but we wanted to enrich the user objects with additional data. Specifically, we wanted to add a property that indicated how long it had been since the user account had been used. In some older domains, that requires pinging every domain controller. We also wanted to filter out user accounts that had *never* been used to log on. So we started thinking about the name such a tool would have.

We always start at [https://learn.microsoft.com/en-us/powershell/scripting/developer/cmdlet/approved-verbs-for- windows-powershell-commands](https://learn.microsoft.com/en-us/powershell/scripting/developer/cmdlet/approved-verbs-for-windows-powershell-commands), which lists the official, allowed verbs for command names. In this case, the *Add* verb seemed like it could work. After all, we were *adding* information to the user objects, and the description for that verb says it means to "…[attach] an item to another item." But *adding* doesn't communicate the *filtering* process we also wanted to do. We struggled with it for a while. "What about *Process* as a verb, because we're really processing

these user objects?” Nope, that’s not a valid verb. “*Evaluate,* maybe?” Nope.

That’s when it dawned on us. We were having trouble because *our tool was doing two things*. It was enriching an object by *adding* information, but it was also *filtering* objects out of the processing queue. The existing `Where-Object` command already does that kind of filtering—we didn’t need to duplicate that within another tool.

Once we stopped trying to force the verbs to work, everything made sense. We needed to create one tool to enrich the user objects, and we also needed to use an existing tool to filter out the ones we wanted. Instead of doing two things in one tool, we did one thing—and we were better off for it. Listening to PowerShell’s verbs, and honoring their intent, can help you make better toolmaking decisions.

6.5.3 Setting file permissions

Here’s a task that may be a bit trickier to think about: “I want to set a file permission on an entire hierarchy of files, but I need to exclude certain file types.” What are the tasks there? This is where it’s sometimes helpful to think about how you’d do this manually. And we mean *really* manually, not using the GUI. Like, if you were Windows *itself*, how would you do this?

“Well, I’d start by getting a list of the files.” Great! PowerShell has a tool that can do that: It can recurse through subfolders and even exclude files based on a specification you provide. “Then I’d need to get their existing permission object, or ACL.” Correct! Again, PowerShell has a native command to do that. “Then I’d need to add a permission to each ACL.” Yes—and again, there’s a command for that. So in this case, your “script” might just be a complex one-liner. It would be a controller, because all the tools you need to use already exist.

NOTE

This example raises a good point that’s sometimes a hard truth to face: If you don’t know much about how Windows (or whatever you’re managing) works under the hood, you’re going to have a hard time automating it in Power-

Shell. The GUI hides a lot of how Windows works, and PowerShell doesn't; start using PowerShell a lot, and you'll quickly realize how much of an expert you are!

6.5.4 Helping the help desk

Suppose your help desk consists mainly of entry-level folks. Not stupid—just with less experience than you. To help them solve common problems and complete common tasks, you decide to create a set of tools for them. They're not command-line comfortable yet, so you decide—using WPF or a commercial tool like PowerShell Studio—to create a GUI for them.

As we've mentioned, a GUI is a form of *controller*. That means it should have an absolutely minimal amount of code: In our view, *zero code beyond that needed to make the GUI work*. Clicking a button in the GUI might run a separate *controller script* designed to automate a given process; that script in turn might call on multiple *tools* to accomplish the tasks within that process. This may seem like a lot of layers, but let us make an argument in favor of the approach:

- GUIs are hard to write and harder to debug. The less code you have in them, the happier you'll be.
- GUIs are never the only place where a given task is accomplished. They should be a way of *triggering* the task, but not the place where the task actually "lives." A GUI that runs a controller script is great, because that same controller script could be run from elsewhere, too.
- A standalone controller script that calls standalone tools is easier to develop and debug. You can focus on solving one task at a time in your tools, bring them together in the controller script, and then call that from whatever GUI you've built.
- By separating things into layers, you're going to help your help desk get better at their jobs. As the *I* in the name clearly states, a GUI is an *interface*—a means of accessing functionality. A PowerShell console is another such interface—a CLI, or command-line interface. If your help desk can summon functionality from either interface, then you'll be able to slowly move them over to the CLI, which will ultimately offer them more flexibility and control as their experience grows. Building your

functionality to be interface independent is a great idea.

6.6 Control more

One last thought on this whole “tools versus controllers” idea is that you shouldn’t forget all the other tools you have at your disposal. Sure, this is a PowerShell book, so we’ve been looking at PowerShell commands and concepts. But if there’s a non-PowerShell tool—perhaps a Microsoft resource kit tool or a vendor-supplied command-line tool—and it makes sense to use, then use it. There’s no requirement that your controller script can only use PowerShell.

Imagine that, for compliance purposes, you must create a report for each server in your domain from the MSInfo32.exe command-line tool. What tools might you need to use? Perhaps `Get-ADComputer` from the ActiveDirectory module to get the computer accounts. You might want to ping the computer first with `Test-Connection` and then, if the computer is online, run the `MSInfo32` command. Your boss could even ask that you record the server names that aren’t online in a separate text file. In the end, you might not need to create any new tools, but rather a controller script to pull together this collection of PowerShell and non-PowerShell tools. It might look something like this:

```
#GetComplianceInfo.ps1
Get-ADComputer -filter * | foreach {
 if (Test-Connection $_.name -quiet) {
    msinfo32 /computer "\\$($_.name)" /report "c:\work\
å $($_.name)-msinfo.txt"
 }
 else {
    $_.name | out-file c:\logs\offline.txt -Append
 }
}
```

6.7 Your turn

Hopefully, this chapter has gotten you thinking about the most important top-level element of scripting: what kind of script to make. And although we haven’t explicitly stated it, often the first step in scripting doesn’t involve

writing any code but rather writing down what you need to accomplish in a very granular fashion. If we did our job in this chapter, you're starting to think about *tools* and *controllers* in the right way—the PowerShell way—and you're beginning to see how they work together to accomplish business tasks. If you can completely embrace the distinction between the two and respect their individual purposes, then you'll be set to succeed in Power-Shell scripting.

With that in mind, let's see how much you've understood about what we've been trying to explain and demonstrate in this chapter. Break out a pencil and paper, and figure out what tools you'd need to accomplish these business problems. Identify those you might have to create and those that already exist. Finally, draft at least an outline of how you might use them. This doesn't have to be actual code:

1. You need to review departmental shares and identify files that haven't been modified in over a year. Your boss wants an Excel spreadsheet that shows the file path, the size, when it was created, when it was last modified, and the file owner. Here's a tip: Don't worry about automating Excel. All you need is a CSV file that can be opened and saved in Excel.
2. Every week, you get a list of user accounts to be terminated. Your manual process is to disable the user account in Active Directory. Add a comment to the user account indicating the date terminated, add the user account to the Terminated-Users group, and send an email to the terminated user's manager.

We won't be supplying any answers or solutions, because the process you go through is more important than the end result right now.

7 Scripts and security

Let’s take a few minutes and talk about security. We covered this a little bit in the predecessor book (Learn PowerShell in a Month of Lunches 4[\1] edition), but we want to discuss this in depth. From our experiences in the field, the instant knee-jerk reaction is that PowerShell should be disabled on every desktop and server on the face of the planet because of how powerful it is and that it is straightforward to use. Major corporations out there have a company-wide ban on using PowerShell for this very reason.

Viruses and malware are becoming more and more sophisticated and increasingly becoming harder and harder to detect. The security engineers for the top companies are good at identifying new attack vectors and helping fix the issues. Still, there are more bad guys out there with so much free time that they are finding new topics faster than they can be set (this is why it is essential to patch your systems!!). The good news is that many bad actors use PowerShell as the attack vector. Wait, but you just said “Good News” how in the world is this a good thing. Microsoft and a few trusted community members helped strengthen the security features built into PowerShell. Think of it as an in-depth defense program with multiple layers of security in place. PowerShell isn’t anti-malware and isn’t intended to protect you should malware become present in your environment. Understanding PowerShell’s security goals are essential, so you don’t overestimate them.

7.1 Security is Number One

First things first, PowerShell will do what you tell it to do. I write a script to get-Process | Stop-Process it will do just that. No warnings, no confirmation on are you sure you want to do this? It will go off and execute the command. That said, there isn’t a way to stop a user from purposely running code they copied and pasted from the internet. That is an HR problem, not a technology problem. But we can put safeguards in place to stop a code's unintentional/unattended execution, which may or may not be malicious. Microsoft’s primary concern is the *accidental* or *unintentional* execution of a

PowerShell script.

But will be creating tools and scripts for yourself and others with the intent of executing (safely) in your organization. To do that, you must be aware of the script security concepts discussed here.

PowerShell as a malware vector

There's little doubt that some bad actors consider PowerShell a convenient way to introduce malware into your environment. But there's something massively important you need to remember: *Anything an attacker could do in PowerShell, they could do without PowerShell, just as quickly.*

PowerShell is nothing more than a wrapper around the .NET Framework at its deepest level. If PowerShell didn't exist, those underlying things would still be there, and attackers would use them instead. Even if your organization completely locks down PowerShell so it can't be used, *you're just giving yourself a false sense of security* because all the underlying functionality would still be available to an attacker.

PowerShell's original goal was to provide an easier way to use things like COM, .NET Framework, and WMI; PowerShell doesn't add any new functionality to your environment. It just adds new *ways of using* the same functionality that's been there all along. Therefore, "locking down" PowerShell doesn't lock down anything except a way to use something—the "something" is still there.

It's like telling someone your house can't be accessed because you've buried all the door keys. The keys were never the only means of accessing your home. They're just the most convenient way. Picking a lock, kicking in a door, and breaking a window is still on the table—only, with the keys buried, *you'll* have to use those less-convenient means, too.

As product team member Lee Holmes famously repeats, "If you're pwned, you're pwned." If you've got a bad actor in the environment, you're already screwed—PowerShell is the least of your concerns. Keeping the bad actors *out* should be your goal, and limiting what they can *get to,* should they break in, should be your second goal. From a security perspective, simply locking

down the tools they might use is a red herring.

7.2 Eexecution policy

By default, on client operating systems, PowerShell won't run any PowerShell script file, no matter who you are or what permissions you have. These are files with a ps1, psm1, pssc, or ps1xml file extension. A machine-wide execution policy controls this behavior. Technically, there are some fine-grained exceptions, but those don't matter for our purposes. Policies only need to be set once, and the effect is immediate. To discover your current setting, run `Get-ExecutionPolicy`. You should see one of the values listed in table 7.1.

Table 7.1 Execution policies

Policy	Description
`Restricted`	This is the default setting for Windows Clients. It means no PowerShell script files will be executed, including profile scripts.
`AllSigned`	Requires any PowerShell script file containing a valid digital signature from a code-signing certificate issued by a trusted certificate authority. We'll cover script signing in chapter 21.
`RemoteSigned`	PowerShell will run any script created locally, signed or not, but will require any other script to be digitally signed. This is the default server setting starting with Windows Server 2012 R2.
	PowerShell will run any script with very few questions asked. You might get a prompt when running a script that

Unrestricted	PowerShell detects as something downloaded from outside your machine. The default setting for Unix and Linux
Bypass	PowerShell will run anything with no questions asked. The implication of this policy is that you've taken your own steps to ensure script safety and integrity.
Undefined	No execution policy can be found. PowerShell will move down the scope list and use the first effective policy it finds. More on that in a moment.

Remember, you only need to allow script execution where you intend to run scripts, which should be your desktop or a centralized management server. You should be able to leave servers at their default settings and only modify your local client setting. You might also consider leaving the policy as `Restricted` on end-user desktops unless you need them running scripts.

Try it now

What is your execution policy set to? Run the command `Get-ExecutionPolicy` to find out

It is recommended that you set the execution policy via Group Policy. This will ensure that each machine in your environment gets the correct execution policy you and your company have decided to use. Read the `about_execution_policies` help topic for more details on these policies.

What about servers?

By default, PowerShell disallows script execution on client computers. Those are the ones most typically operated by less technically sophisticated users who are surfing the web and accessing email.

Servers, however, are different animals. Users shouldn't have interactive

access to them (except Remote Desktop servers, which are more of a multiclient-computer than a server in this sense). Even *administrators* shouldn't be interactively logging on to servers, either (that's right, we said what we said. Stop deploying servers with Desktop Experience, and please start using Server Core! Therefore, on a server OS, modern versions of PowerShell default to allowing script execution. This is often because of the server's configuration tools—like Server Manager or Windows Admin Center!—require PowerShell for them to do their job.

This gets back to PowerShell's security goal: to *slow down* an *unintentional* script execution by an *uninformed* user. *Uninformed* and *unintentional* shouldn't be happening on a server; if they are, you have what we refer to as a "Human Resources problem."

So what do *we* use? Manning will not let us tell you exactly which setting to use in your environment for obvious reasons. But you and the rest of your team must sit down and discuss the best route to go. Obovisloey Microsoft made certain setting the default for a reason, so maybe that is where you should start.

7.2.1 Execution scope

PowerShell's execution policy can be set at one of three scope levels, in this order of precedence:

- *LocalMachine*—Applies to the entire machine and is stored in the configuration JSON file at C:\Program Files\PowerShell\7\powershell.config.json
- *CurrentUser*—Applies only to the current user and is stored in the current user configuration JSON file in your Documents folder (\Documents\PowerShell), assuming it isn't Undefined
- *Process*—Controls the current session and is stored in the system variable `$env:PSExecutionPolicyPreference.` This setting will go away once the PowerShell session is closed.

The setting remains effective for as long as your PowerShell session is open. You can set this by specifying an execution policy switch when you run

PWSH.exe. This demonstrates how easy it is for an informed, intentional user to get around the execution policy—no matter what you do elsewhere, someone can run the shell with `Bypass` if they so desire.

These policies are applied in the order we listed them, even if a more restrictive policy is set lower. For example, scripts will still be executed if you've set the current user policy as RemoteSigned, but the machine policy is Restricted. From a practical point of view, setting a machine policy should be sufficient for most organizations. We feel the other settings are for special use cases and exceptions.

Note

Before you get yourself worked up, if someone or something can make an unauthorized execution policy change, you're already in trouble. If it's some breach, the intruder can already run other arbitrary code outside of PowerShell, and changing your execution policy is the least of your concerns.

If nothing else, this order of application demonstrates that PowerShell was never intended to be a security boundary. We think of the execution policy more like the little hinged plastic shield covering the Big Red Button that launches the nuclear missiles. The execution policy, like that shield, is meant to get in the way of some idiot who leans their elbow in the wrong place at the wrong time. It's not intended to stop someone from taking deliberate action, nor is it designed to stop an intruder who breaks into the missile silo with bad intentions. The intruder can flip back the cover just as quickly as an authorized user, meaning the cover isn't a security mechanism. The security mechanisms would be things like card-keyed doors and armed guards, not the little button cover.

7.2.2 Getting your policies

To see your current execution policy settings, use `Get-ExecutionPolicy`:

```
PS C:\> Get-ExecutionPolicy
Restricted
```

The cmdlet will default return the effective policy based on your scope

settings. In other words, it will return the policy that the current shell instance will obey, regardless of where that setting came from. You can also get the settings for all scopes like this:

```
PS C:\> Get-ExecutionPolicy -List
        Scope ExecutionPolicy
        ----- ---------------
MachinePolicy       Undefined
   UserPolicy       Undefined
      Process       Undefined
  CurrentUser       Undefined
 LocalMachine      Restricted
```

The *policy* scopes are those that would be set via Group Policy, which we're obviously not using. Also, it's worth noting that this list *isn't in order of application*—the order of this list isn't meaningful. In this situation, the `Restricted` policy will apply, which we can verify:

```
PS C:\> C:\work\test.ps1
C:\work\test.ps1 : File C:\work\test.ps1 cannot be loaded because
scripts is disabled on this system. For more information, see
about_Execution_Policies at https:/go.microsoft.com/fwlink/?LinkI
```

Naturally, we need to make a change if we want our scripts to run.

7.2.3 Setting an execution policy

The cmdlet to modify the policy is `Set-ExecutionPolicy`. You need to specify a policy setting and, optionally, a scope. The default is the local machine. To run this command, you must have permission to modify the relevant scope. In other words, if you're trying to alter the local machine setting, you need to be running the shell As Administrator because the local machine setting is stored in the machine configuration JSON file located in Program Files, which only administrators can write to. Note that you can't change either of the Group Policy–managed settings this way; you need to—obviously—use Group Policy for that. You also can't change the process scope's execution policy; that must be established when you run PowerShell, not once it's already running and you're inside it:

```
PS C:\> Set-ExecutionPolicy -ExecutionPolicy RemoteSigned
Execution Policy Change
```

```
The execution policy helps protect you from scripts that you do n
Changing the execution policy might expose you to the security ri
described in the about_Execution_Policies help topic at
https:/go.microsoft.com/fwlink/?LinkID=135170. Do you want to cha
execution policy?
[Y] Yes  [A] Yes to All  [N] No  [L] No to All  [S] Suspend  [?]
(default is "N"):
```

Answer Y at the prompt to make the change. The change is immediate. Note that a normal user can change the execution policy for themselves or the process; that’s why none of this is considered a security boundary.

7.3 PowerShell isn’t the default application

Remember, these settings are intended to prevent PowerShell scripts' accidental or unintentional execution. So, what happens when Missy clicks the attachment in her email to check the shipping status of her amazon order? If it’s a PowerShell script, it won’t execute automatically. By default, the associated application for a .ps1 file is in Notepad, not PowerShell. When Missy clicks because she can’t help herself, the script will be displayed in Notepad. Sure, you can change this association, and some scripting editors will associate themselves with .ps1 and the other filename extensions for script editing. This also applies to any PowerShell file in Windows Explorer: Double-clicking will open the file in Notepad.

It’s possible to create an Execute association with these filename extensions (as opposed to an Edit association). Doing so would make the files execute when double-clicked. We think this is an awful idea, by the way.

7.4 Running scripts

Finally, assuming you’re configured to run scripts, you must provide the path to the script file, even if you’re in the same directory. For example, suppose we have a test script in the current directory that we try to run:

```
PS C:\work> test
test: The term 'test' is not recognized as the name of a cmdlet,
script file, or operable program. Check the spelling of the name,
the path was included; verify that the path is correct and try ag
```

Nope. This is intended to prevent *command hijacking*, where someone or something puts in the folder a malicious script that uses a common command name like `dir`. You need to tell PowerShell you intend to run a script:

```
PS C:\work> .\test
Handles  NPM(K)    PM(K)      WS(K)     CPU(s)     Id  SI Process
-------  ------    -----      -----     ------     --  -- -------
   2517     276  1146832    1082780   2,365.03   1328   1 dwm
      0       0     1884     748852     115.84   5408   0 Memory
   1538     208   992756     353264   4,789.05   8284   1 firefox
    483      62   215324     218868     169.59  12232   1 slack
   1999     111   202616     199176     945.55   4284   1 WINWORD
```

You aren't required to include the file extension, but it never hurts. That way, there's no mistaking what script you intend to run. If you use tab completion, PowerShell will add the filename extension anyway.

You are part of the security system

Keep in mind that you're a part of the overall system when it comes to security. "But we have administrators who can't be trusted to know when a script is safe to run!" Well, that's again what we call an HR problem—those people shouldn't be DevOps Engineers.

That's where command hijacking comes into play. It was a real issue in MS-DOS back in the day due to how it prioritized things. If you ran `Dir`, it would first look for batch files having that name, then executables, and then internal commands—or something like that. It was possible, in other words, to drop in an executable or batch with *the same name as an internal command* and trick people into running the executable or batch instead of the command.

With PowerShell, the trick is more obvious. `Dir` is almost always[1] going to run `Get-ChildItem`; `./Dir` would run Dir.ps1 from the current directory. But *you* have to know the difference. The security "protection" doesn't work if you don't know the difference or if you ignore it. You can still be tricked if you're not vigilant because *you* are integral to what makes the security work.

7.5 Recommendations

What do we typically recommend to people when it comes to execution policy? You may be surprised:

- We suggest using `AllSigned` in cases where certificates will be used to control script releases. This isn't a security thing so much as a procedural thing; your company decides that the signature in the script will certify the script as being ready for production. This also helps clamp down on profile-script injection, which we described in the sidebar in the previous section. `AllSigned` can also be helpful on client computers where you need scripts to run (otherwise, stick with `Restricted`) and where you want to impose limitations on which scripts your users can run. Remember that a user running a script *still can't do anything they don't have permission to do* and that a script isn't the only way malware can take advantage of your users. This isn't a security thing—it's more of a minor hurdle to stop someone from accidentally doing something they might regret.
- We tend to use `RemoteSigned` in most cases. It's a good balance between inconvenience and protection against accidental stupidity. Scripts downloaded through a Microsoft application like Internet Explorer, Edge, or Outlook will be marked as remote by the application, meaning PowerShell won't run them without prompting the user. Of course, this isn't a *security* feature—it's just an extra hurdle. We all know that, confronted with "Are you sure?" all users reflexively answer Yes, so this isn't intended to *stop* anyone or even make them think twice. At most, it makes them think 1.1 times.
- We don't see much practical difference between `RemoteSigned` and `Unrestricted`, except that *most* scripts accessed via a UNC will prompt under `RemoteSigned` and not under `Unrestricted`.
- We suggest `Bypass` when you're not using `AllSigned` for one of the reasons we've stated here and when you don't want the sometimes-false sense of security that `RemoteSigned` and `Unrestricted` can present. Using `Bypass` says, "Hey, I know this execution policy isn't a security layer per se; I'm confident enough in my other security measures, such as strict access control, that I don't even want to use this because I'm afraid *some* people might *perceive* it to be a security layer, and I want to remove that option from their minds."

Here’s why that last bullet is important: Many so-called information security “professionals” won’t take the time to understand PowerShell’s execution policy. Here’s their thought process:

1. In college, we learned that scripts were terrible for security.
2. The execution policy lets me shut down scripting.
3. Malware might not even need scripting, but “defense in depth” means I shut down as much as possible.
4. Therefore, we’ll use `Restricted` for our execution policy.

This thought process misses that any malware author can bypass the Restricted execution policy with two brain cells rub together. We challenge these “professionals” by asking, “Okay, how would you protect the environment if we forced you to set the execution policy to `Bypass`?” Their answers range from outright proper—“Make sure our firewalls are multilayered and that our anti-malware defenses are updated and multilayered”—to the outrageous—“Unplug all the power cords and run for the hills!” Take the execution policy off the table, so to speak, as a security layer (because it isn’t one), and start thinking about actual security policies.

7.6 Summary

The settings surrounding script execution in PowerShell are intended to be as restrictive as possible out of the box. Any changes you make will only relax these settings. You should consider other typical Windows best practices like least-use privilege, email filtering, and good file security. You’ll want to use PowerShell scripts—that’s why you’re reading this book. Your job is to make doing so as safe and secure as possible. Hopefully, we’ve now given you some guidance in that direction. Your action plan for this chapter is to figure out how you’ll apply these ideas in your organization.

[1]By the way, it’s possible to make `Dir` run something other than `Get-ChildItem`. It’s even easy. Just redefine the alias to run another command, or load an alternate command named Get-ChildItem. It’d be incredibly easy, for example, for a piece of malware to inject this into your PowerShell profile script, which is, after all, a plain-text document located in your personal Documents folder, which you obviously have full rights to. It runs every time

you open the shell, and you'd never know anything had gone wrong. That's one argument for using the `AllSigned` execution policy—injecting stuff into your profile would break the signature on it, causing an error when you opened the shell. Provided your code-signing certificate wasn't installed locally (which would be deeply inconvenient), or you password-protected it (better idea), the injection couldn't re-sign the script.

8 Always design first

Most of our scripts start out as a simple one-line command to do a thing, such as creating a new user. The script will read from a CSV and make the new users and fill in all the information you received from HR. You save the script in your C:\ drive somewhere and move on to the next fire.

Does this sound familiar? There are two types of scripters and toolmakers in the world. Those who plan and those who shoot from him. Our goal by the end of the book (hopefully even this chapter) is to make a tool designer. Look at it from the process in reverse. What is the desired outcome and how do I get there. Then fill in the blanks from there.

In this chapter, we're going to lay out some of the core PowerShell tool design principles, to help you stay on the path of Toolmaking Righteousness. To be clear, all we're doing here is building on what we laid out in part 1 of this book. Now we're ready to provide some more concrete examples.

8.1 Tools do one thing

If you have ever heard Don, Jeff or James talk about toolmaking or scripting you have heard each of us get on our soap box and yell from the top of the rafters that a script should perform a single task. It does not create the AD user and create an M365 mailbox, that is two tasks and thus should be separated. This has been the design of PowerShell since the beginning. Look at all the commands that ship with PowerShell natively, they do one thing. Let's look at `Get-Service`, it doesn't stop or start them. All it does is retrieve information about the service(s) and return the data to you. If you want to stop the service you use a different command `Stop-Service`.

This concept is one we see newcomers violate the most. For example, we'll see folks build a command that has a `-ComputerName` parameter for accepting a remote machine name, as well as a `-FilePath` parameter so that they can alternately read computer names from a file. From PowerShell's perspective and ours, that's Dead Wrong, because it means the tool is doing two things

instead of just one. A correct design to follow the paradigm would be to stick with the `-ComputerName` parameter and let it accept strings (computer names) from the pipeline. You could also feed it names from a file by using a `-ComputerName (Get-Content servers.txt)` parenthetical construct. Or define the `-Computername` parameter to accept input by value:

```
Get-Content servers.txt | Get-ServerInfo
```

The `Get-Content` command exists for the sole purpose of getting data from a file so why should you create something that does that? Spend your time on the important things and stop trying to reinvent the wheel. The good folks at Microsoft spent a lot of time producing meaningful PowerShell commands.

Let's explore that antipattern for a moment. Here's an example of using a completely fake command (meaning, don't try this at home) in two different ways:

```
# Specify three computer names
Get-CompanyStuff –Computername ONE,TWO,THREE
# Specify a file containing computer names
Get-CompanyStuff –FilePath ./names.txt
```

That approach overcomplicates the tool, making it harder to write, harder to debug, harder to test, and harder to maintain. We'd go with this approach to provide the exact same effect in a simpler tool:

```
# Specify three computer names
Get-CompanyStuff –Computername ONE,TWO,THREE
# Specify a file containing computer names
Get-CompanyStuff –Computername (Get-Content ./names.txt)
# Or if you were smart in making the tool...
Get-Content ./names.txt | Get-CompanyStuff
```

Those patterns do a much better job of mimicking how PowerShell's own core commands work. But let's explore one more antipattern, which is "but I have the computer names in a specially formatted file that only I know how to read." Folks will convince themselves that this is okay:

```
# Specify three computer names
Get-CompanyStuff –Computername ONE,TWO,THREE
# Specify a file containing computer names
```

```
Get-CompanyStuff –FilePath ./names.dat
```

TIP

Did you know that PowerShell can not read a .DAT file natively? This was introduced in PowerShell 6.

8.2 Tools are testable

Another thing to bear in mind is that—if you're trying to make tools like a real pro—you're going to want to create automated unit tests for your tools. We'll get into how that's done in chapter 20. There is a huge debate in the PowerShell community when it comes to testing. Some community members say that you should write your test first, then write the code after the fact. This ensures that you are working towards your end result. The other half says that you should get your code working correctly first, then write your tests to ensure that it keeps working correctly once you have added new functionality.

We cannot tell you which method is correct because it is a personal preference that you have to decide on. But from a design perspective, you want to make sure you're designing tools that are, in fact, testable. One way to do that is, again, to focus on tightly scoped tools that do just one thing. The fewer pieces of functionality a tool introduces the fewer things and permutations you'll have to test. The fewer logic branches within your code, the easier it will be to thoroughly test your code using automated unit tests.

For example, let's say you are tasked with creating a new process for onboarding new employees. You could create a monothlic 100+ line script that will read the CSV from HR, and create a login name that fits your company standards, check AD to see fit that name already exists, create the user in AD with all the info you received from HR, Create the user's mailbox in Microsoft 365, add the user to Sharepoint Online groups…You can see where this is going. Now here is the bad news, this is the exact thing we are talking about. This script does way to many things and needs to be broken out

Figure 8.1 Need good caption name here showing mulitple scripts vs a signle script

New-Employee

Create AD User
Create M365 Mailbox
Add to SharePoint Online
Add to Global Groups

New-Employee

Create AD User
Create M365 Mailbox
Add to SharePoint Online
Add to Global Groups

You also want to avoid building functionality into your tools that will be difficult to test. For example, you might decide to implement some error logging in a tool. That’s great—but if that logging is going to a SQL Server database, or a SIM tool, it will be trickier to test and make sure the logging is working as desired. Logging to a file might be easier, because a file would be easier to check. Easier still would be to write *a separate tool* that handles logging. You could then test that tool independently and *use it* in your other tools. This gets back to the idea of having each tool do one thing, and one thing only, as a good design pattern.

8.3 Tools are flexible

You want to design tools that can be used in a variety of scenarios. This often means wiring up parameters to accept pipeline input. For example, suppose you write a tool named Set-MachineStatus that changes some setting on a computer. You might specify a `-ComputerName` parameter to accept computer names. Will it accept one computer name, or many? Where will those computer names come from? The correct answers are, “Always assume there

will be more than one, if you can," and "Don't worry about where they come from." From a design perspective, you want to enable a variety of approaches.

It can help to sit down and write some examples of using your command that you *intend to work*. These can become help-file examples later, but in the design stage they can help make sure you're designing to allow all of them. For example, you might want to be able to support these usage patterns:

```
Get-Content names.txt | Set-MachineStatus
Get-ADComputer -filter * | Select -Expand Name | Set-MachineStatu
Get-ADComputer -filter * | Set-MachineStatus
Set-MachineStatus -ComputerName (Get-Content names.txt)
```

That third example will require some careful design, because you're not going to be able to pipe an AD computer object to the same `-ComputerName` parameter that also accepts a `String` object from `Get-Content`! You may have identified a need for two parameter sets, perhaps one using `-ComputerName <string[]>` and another using `-InputObject <ADComputer>`, to accommodate both scenarios. Now, creating two parameter sets will make the coding, and the automated unit testing, a bit harder—so you'll need to decide whether the tradeoff is worth it. Will that third example be used so frequently that it justifies the extra coding and test development? Or will it be a rare enough scenario that you can exclude it and instead rely on the similar second example?

The point is that every design decision you make will have downstream impact on your tool's code, its unit tests, and so on. It's worth thinking about those decisions up front, which is why it's called the *design phase*!

8.4 Tools look native

Finally, be careful with tool and parameter names. We went over this in part 1, but it's worth repeating, because we see people get "creative" all the time. Tools should always adopt the standard PowerShell *verb-noun* pattern and should only use the most appropriate verb from the list returned by `Get-Verb`. Microsoft also publishes that list online (https://docs.microsoft.com/en-us/powershell/scripting/developer/cmdlet/approved-verbs-for-windows-

powershell-commands); the online list includes incorrect variations and explanations that you can use to check yourself. Don't beat yourself up *too* hard over fine distinctions between approved verbs, like the difference between Get and Read. If you check out that website, you'll realize that `Get-Content` should probably be `Read-Content`; it's likely a distinction Microsoft came up with *after* `Get-Content` was already in the wild.

We also recommend that you get in the habit of using a short prefix on your command's noun. For example, if you work for Globomantics, Inc., then you might design commands named Get-GloboSystemStatus rather than just Get-SystemStatus. The prefix helps prevent your command name from conflicting with those written by other people and it will make it easier to discover and identify commands and tools created for your organization.

Note

One reason we went on about native patterns in part 1 of this book is that they're so important. Don't ever forget that the existing commands, particularly the core ones authored by the PowerShell team at Microsoft, represent their vision for how PowerShell works. Break with that vision at your own peril!

Parameter names should also follow native PowerShell patterns. Whenever you need a parameter, take a look at a bunch of native PowerShell commands and see what parameter name they use for similar purposes. For example, if you needed to accept computer names, you'd use `-ComputerName` (notice it's singular!) and not some variation like "MachineName". If you need a filename, that's usually `-FilePath` or `-Path` on most native commands.

The verb quandary

One area where you can get a bit wound up is in choosing the right verb for your command name. Honestly, Microsoft probably has too many verbs to choose from, and although we're sure someone in the company had a clear idea of the differences among them all, that hasn't always been well-communicated to the PowerShell public. For example, if you're writing a command that will retrieve information from a SQL Server database, is the

command name Get-MyWhatever-Data, or is it Read-My-WhateverData? The company offers some guidance, stating, "The `Get` verb is used to retrieve a resource, such as a file. The `Read` verb is used to get information from a source, such as a file." This implies `Get` would be used to *get a file*, meaning an object representing the file itself, whereas `Read` would be used to retrieve *the contents of the file*. Except that `Get-Content` is a thing, so Microsoft didn't even take its own advice.

Our advice? Do what seems to be the most consistent with whatever's already in PowerShell. If you're truly stuck, post a question in the forums at Powershell.org to get a little feedback from experienced pros.

8.5 For example

Before you can even starting making design decisions you must first look at the business requirements. Then try to translate those business requirements to usage examples so it's clearer to you and your team how a tool might be used. If other stakeholders are involved—such as the people who might consume this tool, once it's finished (i.e. helpdesk)—you can get them to sign off on this functional specification so that we can go into the design phase with clear, mutual expectations for the new tool. Also try to capture *problem statements* that this new tool is meant to solve, because those sometimes offer a clearer business perspective than a specification that someone else may have written.

Business Problem: We have a lot of different computers deployed in our company, which have different hardware vendors, different versions of Windows, different configurations, and so on. When users call the help desk, it's often difficult for the technicians to figure out what kind of computer they're dealing with. Users aren't always aware of details like model numbers, OS versions, installed RAM, and so on. We have a configuration management system the help desk can check, but it isn't always up to date or accurate. We'd like a tool that the help desk can use to quickly query a computer, if it's online, and get some key information about its OS and hardware configuration. In some cases, we have downtime and can query that information from multiple computers and double-check the accuracy of the configuration management system. The help desk can update that database if

it needs updating.

Be careful of context

When you start designing tools, it's fine to make business-level problem statements. That's a large part of what the design is for, after all! Statements like, "When users call the help desk, it's often difficult for the technicians to figure out what kind of computer they're dealing with," are fantastic.

Stating desired outcomes, such as when we wrote, "We'd like a tool that the help desk can use to quickly query a computer," is fine as well—it defines a business need. But it's *hugely important* that not every business statement be something you try to solve with a *single* tool or command. You may find that you need a suite of tools, which could be packaged as a module…but we're getting ahead of ourselves.

We've gone on at length about the need for tools to be as detached as possible from a particular context, yet our business statement has provided a very clear context: "We want technicians to query things." That context leads to certain assumptions, like, "The output needs to be human-readable," and maybe, "Our technicians aren't that experienced, so a GUI will be needed for them to operate this thing." This is good background information, but it doesn't mean you're going to solve it all with a single tool.

Our complete business statement kind of implies the creation of a tool to do the data retrieval, and perhaps a controller script to provide the help desk with an input/output interface. The *tool* doesn't need to worry about how the technician uses it or what the technician will see as a result; the *controller* can worry about those context-specific things and use the *tool* under the hood to get the data.

Never lose track of the tool/controller design pattern. Get used to reading business statements that will ultimately need tools *and* controllers, and understand which elements of a business solution will be best solved by each type of script.

Taking the last part of the previous sidebar to heart would lead us to some more detailed questions, asking for specifics about what the tool needs to

query. Suppose the answer came back as follows:

- Computer host name
- Manufacturer
- Model
- OS version and build number
- Service pack version, if any
- Installed RAM
- Processor type
- Processor socket count
- Total core count
- Free space on system drive (usually C: but not always)

That’s fine—we know we can get all that information somehow. We know we’re going to write a tool, maybe called Get-MachineInfo, and it will probably have at least a `-ComputerName` parameter that accepts one or more computer names as strings. Thinking ahead, we might also start making notes for an `Update-OrgCMDatabase` command, which could consume the output of Get-MachineInfo and automatically update the organization’s configuration management database. Nobody *asked* for that, but it’s kind of implied in the business problem statements, and we can see them asking for it once we deliver the first tool—“Hey, because the tool gets all the data, is there any way we can have it just push that into the CM database?” We’ll keep that in mind as we design the first tool—we want to ensure that the tool is outputting something that could be easily consumed by another command sometime in the future.

We’ll assume that some computers won’t respond to the query, and so we’ll design a way to deal with that situation. We’ll also assume that we have some old versions of Windows out there, so we’ll make sure the tool is designed to work with as old a version of Windows as possible, as well as the latest and greatest.

Our design usage examples might be pretty simple:

```
Get-MachineInfo -ComputerName CLIENT
Get-MachineInfo -ComputerName CLIENTA,CLIENTB
Get-MachineInfo -ComputerName (Get-Content names.txt)
Get-MachineInfo -ComputerName (Get-ADComputer -id CLIENTA |
```

```
Select -Expand name)
Get-Content names.txt | Get-MachineInfo
Get-ADComputer -id CLIENTA | Select -Expand name | Get-MachineInf
```

The second chunk of examples will all require the same design elements, whereas the last chunk of examples will all be made possible by another set of design elements. No problem. The output of these should be pretty deterministic. That is, given a specific set of inputs, we should get the same output, which will make this a fairly straightforward design for which to write unit tests. Our command is only doing one thing, and it has very few parameters, which gives us a good feeling about the design's tight scope.

The beauty of usage examples in design

Stating usage examples as part of your tool design is a *wonderful* idea. For one thing, it helps you make sure you're not bleeding from *tool* design into *controller* design. If your usage examples start to take up 10 sheets of paper and look complicated, then you know you're probably not scoping your tool's functionality tightly enough, and you might be looking at several tools instead of just one.

Usage examples can also become part of your eventual help file. There's a school of thought that you should *start* tool design by *writing the help file*. The help file can then exist as a kind of functional specification, which you code to. Similarly, writing usage examples can help support *test-driven development* (TDD), in which you write automated tests *first*, to sort of specify how your tool should work, and *then* write the code.

Writing usage examples first can also help you avoid bad design decisions. If you're struggling to write all the examples you know you need, and you still keep coming up with an overly long or overly complicated list, then you know you're on the wrong track entirely. It might be worth sitting down with a colleague to try and refactor the whole project to keep it simpler.

We'd take that set of examples back to the team and ask what they think. Almost invariably, doing so will generate questions.

How will we know if a machine fails? Will the tool keep going? Will it log

that information anyplace?

Okay—we need to evolve the design a bit. We know that we need to keep going in the event of a failure and give the user the option to log failures to, perhaps, a text file:

```
Get-MachineInfo -ComputerName ONE,TWO,BUCKLE,SHOE
  -LogFailuresToPath errorlog.txt
```

Provided the team is happy with a text file as the error log, we're good including that in the design. If they wanted something more complicated—the option to log to a database or to an event log—then we'd design a separate logging tool to do all of that. For the sake of argument, though, let's say they're okay with the text file. at this stage to figure out *how* we'll do all that; right now, we're just designing the thing.

Let's say that the team is satisfied with these additions and that we have our desired usage examples locked down. We can now get into the coding. But before we do, why don't you take a stab at your own design exercise?

Designing sets of commands

The forgoing discussion is great when you're writing a command to do something self-contained, like retrieving management information from multiple computers. There's a slightly different discussion, however, when you start writing sets of commands to help manage a large system.

For example, suppose you want to write a set of commands to help manage a customer information-tracking application. What commands might you need to write?

Start by inventorying the *nouns* in the system. What are the things that the system works with? Users? Customers? Orders? Items in an order? Addresses? Write down that list somewhere.

Next, look at each noun and decide what the system can *do* with it. For users, what tasks does the system offer? Creating new ones? Removing them? Modifying existing ones? Listing them all? Those give you your verbs—*New*,

Remove, *Set*, and *Get*, in this case, yielding commands like New-SystemUser, Remove-SystemUser, Set-SystemUser, and Get-SystemUser (assuming *System* is a useful prefix for your organization).

This little inventory exercise helps make sure you're not missing any key functionality. Having the command list doesn't automatically mean you're going to *write* all of those commands, but it does give you a checklist to prioritize and work against.

8.6 Your turn

If you're working with a group, this will make a great discussion exercise. You won't need a computer, just a whiteboard or a pen and paper. The idea is to read through the business requirements and come up with some usage examples that meet the requirements. We'll provide *all* the business requirements in a single statement, so that you don't have to "go back to the team" and gather more information.

8.6.1 Start here

Your team has come to you and asked you to design a PowerShell tool that will help them automate a repetitive, boring task. They're all skilled in *using* PowerShell, so they just need a command or set of commands that will help automate this task.

You've been lazy about changing service logon passwords. Many have been switched over to Group Managed Service Accounts, so you don't need to, but you have a lot of services—many of which run on multiple computers in a cluster—that haven't had a password change in years. The native `Set-Service` command doesn't do it. You'd like a tool that will let you change the logon user account as well as the password, for a single service, on one or more machines at once. If any machine fails, you need to know about it so you can handle it manually. Displaying onscreen and/or logging to a text file is fine.

This needs to run on a variety of Windows Server versions. You don't usually need to script this, so the password can be provided in clear text on

the command line as a parameter. You'd like the command to output something no matter what happens—such as the name of each computer and whether it succeeded, the service it was changing, and the logon account the service is now using (whether that was changed or not). You'll usually want that output either onscreen, in a simple HTML report, or in a CSV file you can load into Microsoft Excel.

8.6.2 Your task

Your job is to design the tool that will meet the team's business requirements. You are *not* writing any code at this point. When creating a new tool, you have to consider who will use the tool, how they might use it, and their expectations. And the user might be you! The end result of your design will be a list of command usage examples (like those we've shown you), which should illustrate how each of the team's business needs will be solved by the tool. It's fine to include existing PowerShell commands in your examples, if those commands play a role in meeting the requirements.

Try IT NOW

Stop reading here, and complete the task before resuming.

8.6.3 Our take

We'll design the command name as Set-TMServiceLogon. The *TM* stands for *Toolmaking*, because we don't have a specific company or organizational name to use. We'll design the following use cases:

```
Set-TMServiceLogon -ServiceName LOBApp
                   -NewPassword "P@ssw0rd"
                   -ComputerName SERVER1,SERVER2
                   -ErrorLogFilePath failed.txt
                   -Verbose
```

Our intent is that `-Verbose` will generate onscreen warnings about failures, and `-ErrorLogFilePath` will write failed computer names to a file. Notice that, to make this specification easier to read, we've put each parameter on its own line. The command won't *execute* exactly like that, but that's fine—

clarity is the idea at this point:

```
Set-TMServiceLogon -ServiceName OurService
                   -NewPassword "P@ssw0rd"
                   -NewUser "COMPANY\User"
                   -ComputerName SERVER1,SERVER2
```

This example illustrates that `-ErrorLogFilePath` and `-Verbose` are optional, as is `-New-User`; if a new user isn't specified, we'll leave that property alone. We also want to illustrate some of our flexible execution options:

```
Get-Content servers.txt |
  Set-TMServiceLogon -ServiceName TheService -NewPassword "P@ssw0
```

This illustrates our ability to accept computer names from the pipeline. Finally

```
Import-CSV tochange.csv | Set-TMServiceLogon | ConvertTo-HTML
```

We're illustrating two things here. First is that we can accept an imported CSV file, assuming it has columns named ServiceName, NewPassword, ComputerName, and, optionally, NewUser. Our output is also consumable by standard PowerShell commands like `ConvertTo-HTML`, which also implies that `Format-` commands and `Export-` commands will also work.

Big designs don't mean big coding

We usually create initial designs that are all-encompassing. That doesn't mean we immediately sit down and start implementing the entire design. In software, there's a difference between *vision* and *execution*.

We're just talking about PowerShell commands, so there's perhaps no need to go all philosophical on you, but this is an important point. You may have no desire right this minute to implement error logging in your command. Fine. That doesn't mean you can't *plan for it* to someday exist. Planning—in other words, having a *vision* for your code—means you can take that into account as you write the code you *do* need right away.

"You know, I have no plans to log failed computers right now, but I know I will someday. I'll go ahead and implement a code structure that'll be easier to

add logging to in the future.” Your execution today, in other words, doesn’t have to be the entire vision. You can create your vision now and then execute it in increments as you have time and need.

9 Avoiding bugs: Start with a command

Before we ever fire up a script editor, we start in the basic PowerShell command-line window. This is your lowest common denominator for testing, and it's a perfect way to ensure the commands your tool will run are correct. It's way easier to debug or troubleshoot a single command from an interactive console than it is to debug an entire script. And by "a single command," we mean a PowerShell expression—a single thing that we can manually type into the console to see if we've got the right syntax. You will start to notice a theme from here on out. Start small (with a single command), get that working, then start building from there. Don't try to write your entire script all at once. This will make it almost impossible to debug.

This is by design

One of the cool parts about PowerShell is that you can open a console, run commands, and get immediate results (good or bad). Traditionally, programmers have had to write code as best they could, compile it, and possibly even code up a test harness so that they could test their code. Take advantage of PowerShell's immediacy to reduce your overall workload!

9.1 What you need to run

If you've already read the previous chapter, then you know that in the example scenario, you've been asked to develop a tool that will query the following information-:

- Computer hostname
- Manufacturer
- Model
- OS version and build number
- Service pack version, if any

- Installed RAM
- Processor type
- Processor socket count
- Total core count
- Free space on system drive (usually C: but not always)

You should plan on using CIM as WMI was deprecated in Windows PowerShell. You will also need to log information to a text file as well. You'll need to do more in terms of the tool itself, but these are the basic units of functionality you need to figure out.

At this point we are in the design phase. The goal in this chapter, then, is to identify what we call the *moving parts* of your script. Yeah, the script will involve some logic and stuff, which will control what commands are eventually executed. But we're not to that point yet. First, you want to figure out *which commands to run*, *how to run them*, and whether you've got the right syntax. You also need to think about the *ways* in which to run a command.

Speaking of goals, let's be specific about what you need to figure out:

- What command or commands will you need to run?
- What classes of data will you need to query?
- What modifications will you need to make in order to try both protocols?
- How do you log errors to a text file?

The discovery process

We are not going to go through the whole process of "How do I find what command to run?". That's because about a quarter of *Learn Windows PowerShell in a Month of Lunches* is devoted to that process, and we assume you've read that or have equivalent education or experience.

But it's *super important* that you get good at the command-discovery process. If every toolmaking project you undertake has to start with a three-week Google-based investigation just to figure out what commands you'll need to make your tool work, then you're going to be inefficient and

frustrated—and, frankly, you need some more basic PowerShell experience before diving into toolmaking.

It's equally important that you get comfortable *experimenting* at the command line. Read examples from the help files, and try things. In classes and at conference presentations, we'll always have people ask things like, "What if I try an IP address instead of a computer name?" For pity's sake, *you're sitting right in front of the computer*. Try it. See what happens. Playing around is how we learned half of what we know ("messing around" covered the other half), so get used to experimenting! Worried about trashing your desktop? Spin up a test virtual machine with Windows 11 or Windows Server 2022, and go to town.

Sure, there's a *lot* that can go wrong here. That's part of the process. You might get the wrong command to start with. You might even use the wrong command and that's ok as well. Once you find the right command, you might make bad assumptions about the results it creates—and those bad assumptions will create bugs further down the line. The command might work fine locally, but not against a remote computer—and you need to figure that out before you do anything else. The command might work against some versions of Windows, but not others, and you need to solve that problem, too. These are all things to get out of the way *before you open a script editor*. We swear to you, there would be fewer bugs in the world if people just tested stuff thoroughly in an interactive console before they started coding.

Note

The reason most .NET Framework developers like PowerShell is that it lets them interactively play with .NET. They don't have to write a huge program, compile it, and run it to see whether they've got the right idea for their code —they can try it quickly in PowerShell, validate their assumptions, and code with confidence. It's the same thing for PowerShell scripters—test it in the console, get it working in every way it will need to work, and *then* start scripting. Don't worry, we will go more in-depth in Debugging your script with VSCode later in this book

9.2 Breaking it down, and running it right

If you don’t already have the PowerShell console open, go ahead and do that (Either with Windows Terminal or PowerShell Console. Notice we didn’t say VSCode. Let’s take a good, concrete example. Suppose we hop into the PowerShell console and run this:

```
Get-CimInstance -ClassName Win32_ComputerSystem
```

Try it Now

By the way, feel free to follow along and try these commands. Nothing in this chapter will break anything, and it’s a good experience.

Did it work? Have we successfully tested our command the way our script will use it? *No, we haven’t!* That’s because our script will clearly need to run this command *against remote computers*, but we’ve only run it against the local computer here. Not the same thing at all, and running against a remote computer obviously brings in a lot more complexity.

Here’s a better test in the console, because it’s closer to what our script will probably need to run (assuming SRV2 is a legitimate server name in our environment that we have admin access to, of course, or substitute your computer name):

```
Get-CimInstance -ClassName Win32_ComputerSystem -ComputerName SRV
```

The point is to not only identify the moving parts of your script but also make sure you’re thinking about *how your script will run them* so that you can test them from the console exactly the same way. We should run this against a few computers with different versions of Windows, too. (It pains me to say this but I know there are a few of you out there still running Windows XP for what ever business reasons you may have. It’ll fail, if you’re still using those dinosaurs, and now’s the time to discover that fact.)

Tip

We can’t tell you how many times we’ve helped people in the forums at PowerShell.org who’ve started up a script editor and begun typing. We invariably end up asking them to run some command “from the console,” so

that they can more clearly see what they're doing wrong. You'll save yourself a ton of time if you don't get ahead of yourself!

The importance of a test environment

You need a safe place to play.

Discovering how to use PowerShell commands invariably involves an amount of experimentation, and your organization's production network is likely not the best place for that to happen. That's why virtualization is so wonderful—using a product like VMware Workstation, VMware Fusion, VirtualBox, Parallels, Hyper-V, Azure Virtual Desktops, and so on, you can run multiple computers on a single machine and have your own test lab. You can also set up test labs (with permission) on your organization's virtual infrastructure, use cloud-based environments like Microsoft Azure or Amazon Web Services, and so on.

We sometimes run into frustrated individuals who are trying to learn this stuff on their own and can't afford an Azure or AWS subscription. They don't have an organization's resources to rely on, and perhaps their home computer doesn't have the juice to run two or three virtual machines. Unfortunately, that's kind of the price of admission. PowerShell, and toolmaking, is a business-class set of technologies that require business-class resources. It *can* be tough to learn on your own but there isn't always a super-inexpensive way to experiment with these kinds of tasks.

Once you have some decent hardware with 8–16 GB of RAM and good disk space, if it at last runs Windows 10 or Windows Server 2016, you can use the AutomatedLab project from https://AutomatedLab.org to make it easy to spin up preconfigured test environments.

There's more to it than just running commands and hoping you don't get any errors. You need to look at the *results* of those commands. Are you hoping the previous command returns a version number for Windows? Well—you should run the command and see what happens. Because many commands have a prettified default onscreen display, we always recommend piping the results to `fl *` (`Format-List *`) so that you can see the full, unadulterated output right in front of you. Which properties will you use? What do they

contain? Do you know what those contents mean? Do they differ from computer to computer in any way that will affect the script you're planning to write?

9.3 Running commands and digging deeper

We're going to assume that you already know how to run PowerShell commands. If that's not your strong suit, please stop and go read *Learn Windows PowerShell in a Month of Lunches*, because it's all about discovering and running commands. Our point is that you should test and make sure you know how to accomplish everything your tool needs to accomplish, by manually running commands in the command-line window.

In this specific case, you want to also make sure you know how to reliably retrieve all the information in your list, which is going to involve more than one CIM class. You'll need `Win32_OperatingSystem` and `Win32_ComputerSystem` at the least. You'll also have to use one of those to determine which drive is the system drive and then retrieve its instance of `Win32_LogicalDisk` to get the free space. Again—you should know how to do these things already if you're reading this book, so we're not going to walk through that entire discovery process.

You see, our "discovery and test" process is about more than just finding what commands to run and what syntax to use. We also, as suggested in the previous section, spend time looking at the output of those commands. In which exact property of `Win32_OperatingSystem` or `Win32_ComputerSystem` will you find the system drive? Is it formatted as C: or C or C:\? Or is it a number, like 0 or 1? What value will you need to use in order to get the corresponding `Win32_LogicalDisk` instance? The idea is to figure out *all* of your "How do I…?" questions up front, test your answers at the console, and go into the actual scripting process with working commands, notes, and everything else you need to do it right the first time.

TIP

If you don't use some kind of note-taking application, get one. As you start to figure out what you'll need to do in a script, it's incredibly valuable to have a

place to jot down electronic notes. In many cases, you'll want to copy and paste things *from* those notes, which is why a big spiral notebook and a pen aren't as useful.

You're going to use `Get-CimInstance` to do the querying; and, because you'll eventually end up querying multiple classes, you'll need to make multiple queries. Might that be slow? We'd test it. We'd also take the time to read the help—the *full* help, mind you, including the examples—and in doing so, we'd discover that there's a way to create and reuse a persistent connection, making multiple queries faster. We love faster! Therefore, you'll use `New-CimSession` and `Remove-CimSession` to create (and then remove) a persistent connection to each computer, so that you can run all the queries over one connection. You'll need to be able to detect errors in case the connection doesn't work. Review the help for `New-CimSession` if you're not familiar with those tasks—it's time for you to figure it all out.

TRY IT NOW

Seriously, read the help. Do it right now. How would you go about creating and removing a persistent session? *Try* it—see if you can make it work, and query an instance of `Win32 _LogicalDisk` from a remote computer or two.

9.4 Process matters

We mentioned this at the beginning of the chapter as an aside, but it's so important that it bears reinforcement. The process of discovery, testing, and refining your command should continue throughout your development process. We've seen students in class spend an hour writing lines and lines of code in the VSCode. Then they run it. And it fails. And they curse. Despite our best efforts, they ignore our advice to discover, test, and code *as you write your script or tool*. Discover/test/code is a great reason to use the PowerShell extension in VSCode. You can find the commands you need, enter them, and run them just that much more easily, right within the editor. If it fails, you can fix it, then and there, and repeat the process. Once you get it right, copy and paste the working code into your script, and you're on your way. Then, move on to the next part of your script. PowerShell is immediate. Take advantage of it.

9.5 Know what you need

We've developed a little saying that isn't exactly reassuring, but it's a hard truth that you can't avoid. "PowerShell," our saying goes, "is easy. Windows is hard." The point of this is that a lot of us—thanks to years of being insulated from the operating system by a GUI—don't know what it's doing under the hood. Do you know the difference between a partition, a disk, a logical disk, and a disk volume? The operating system knows, but it doesn't always surface those distinctions in its GUI. If you don't know the difference, then working from PowerShell—which is a lower-level form of control than the GUI—is going to be hard.

This comes up *all the time* in the forums on PowerShell.org. Someone will ask for help with a block of code, and they'll paste in what amounts to a C# program, because they're really using PowerShell to access a bunch of raw .NET Framework stuff. PowerShell, in that case, isn't the question—it's all the esoteric .NET things. Or, someone will ask something like, "Where can I find a list of events from USB device insertions?" That's a spot-on question. It's not a *PowerShell* question, but it highlights what ends up being difficult: dealing with the underlying operating system.

All of this is why the discover/test/code process is so vital. First, you've got to figure out *what* to do, and then *how* to do it, and the interactive PowerShell console is the place for that. Once you know *what* and *how*, you can start assembling it all into a script using your script editor.

9.6 Your turn

The previous chapter included an exercise for you, and this one picks up where it left off. This is where you'll get to practice what we've preached in this chapter: making sure you know how to accomplish everything your tool will need to do, by starting in the PowerShell command-line window. If there's *anything* about the tasks to perform that you don't know how to do, *figure it out before you leave this chapter*.

9.6.1 Start here

Remember that you've designed a tool that will change service logon names and passwords. You won't be able to use `Set-Service` for this (it doesn't offer the ability to change those things); you'll need to use CIM.

9.6.2 Your task

Your main task is to discover the CIM class that will let you change a service's logon name and password. A search engine is probably the best way to start looking for this, and we'll give you one hint: The class name starts with `Win32_`.

You also need to make sure you can use this class to accomplish the task. You'll need to *invoke* something in CIM. Here's a tip: When experimenting with services, we usually play with the Background Intelligent Transfer Service (BITS), or the Print Spooler. Messing with it won't crash Windows, which is great. But if you're working on a non-lab computer, keep in mind that BITS is what makes Windows Update and some other important things work. After you've finished playing with it, be sure to reset it so that it's logging on as LocalSystem, with no password set.

DO IT NOW

Stop reading here, and complete the task before resuming.

9.6.3 Our take

We found that the `Win32_Service` class will do the trick. We learned this, honestly, by hopping on Google, entering `change windows service password`, and looking for a Microsoft.com page (http://mng.bz/1noL) in the results.

We also ran `Get-Command -verb invoke` in PowerShell, given that *invoke* was a not-so-subtle hint in the lab assignment. We found `Invoke-WmiMethod`, but also `Invoke-CimMethod`; and given our modern way of doing things, we're going with `Invoke-CimMethod`. We read its help file and came up with the following command to change the startup username and password for the BITS service:

```
Invoke-CimMethod -Query "SELECT * FROM Win32_Service WHERE Name='
                 -Method Change
                 -Arguments @{'StartName'='DOMAIN\User';
                              'StartPassword'='P@ssw0rd'}
                 -Computername $env:computername
```

We won't lie—coming up with that took a bit of experimentation and searching (yay, Google!). We wound up using `-Query` because we need a specific instance of `Win32_Service`, not *all* the services on the computer. Also, we noticed a `-ComputerName` parameter that should be useful later, when we're targeting remote machines. To make sure we're using it properly, we'll use the environmental variable for the local computer name. This should verify the complete syntax we'll eventually incorporate into our tool.

DOMAIN is valid in our test environment, but obviously, you'd need to use a proper username in that DOMAIN\USERNAME form. We noted that the command returned an object, and `ReturnValue` was 0 for a success and 22 when we provided an invalid username. The `Change` method's web page, which we gave a link to earlier, includes all the valid return codes. We could capture that return object into a variable to make sure each computer is successful when we write our tool.

Now, look: If WMI/CIM isn't your thing, this may have been hard to come up with on your own. We get it. This isn't a book about WMI/CIM, however, so we're hoping you brought that knowledge with you. If not, you might want to grab a copy of *PowerShell and WMI*, written by our good friend Richard Siddaway (Manning, 2012, www.manning.com/books/powershell-and-wmi).

We were, by the way, careful to reset the service:

```
Invoke-CimMethod -Query "SELECT * FROM Win32_Service WHERE Name='
                 -Method Change
                 -Arguments @{'StartName'='LocalSystem'}
```

Take the time to follow the process. It's really important that you start building some PowerShell toolmaking muscle memory.

10 Building a basic function and script module

Remember the tool we made back in Chapter 8? Well go ahead and fire up VSCode and open that ps1 file. In this chapter we are going to take the tool you designed in Chapter 8 and turn that into a reusable tool for other's to use. It's important to understand that this chapter isn't going to attempt to have you build the entire tool or solve the entire business statement from chapter 8. We'll take things one step at a time, because it's the process of toolmaking that we want to demonstrate for you.

10.1 Starting with a basic function

Basic functions have been a part of PowerShell since day one, and they're one of the many types of *commands* that PowerShell understands (some of the others being cmdlets, applications, and so on). Functions make a great unit of work for toolmaking, as long as you follow the basic principle of *keeping your function tightly scoped and self-contained*. We've written already about the need to have tightly scoped functions—that is, functions that do just one thing. *Self-contained* means the function needs to live in its own little world and become a kind of black box. Practically speaking, that means two things:

- Information to be used inside the function should come only from declared input parameters. Of course, some functions may look up data from elsewhere, like a database or a registry, and that's fine if it's what the function does. But functions shouldn't rely on external variables or sources other than intrinsic items like PSDrives to the file system or environmental variables. You want them as self-contained as possible.
- Output from a function should be to the PowerShell pipeline *only*. Stuff like creating a file on disk, updating a database, and other actions aren't *output*, they're *actions*. Obviously, a function can perform one of those actions *if that's what the function does*.

Designing function output

Let’s harp on this for a moment, because it’s one of the first things people get wrong. PowerShell’s `Write-Output` command is the shell’s *default command*. That is, if you give the shell some kind of expression all by itself, the shell uses `Write-Output`. For example, hop into the shell, type `5+5`, and press Enter. You see the result on the screen, right? Well, in reality, the shell basically ran something like `Write-Output (5+5)` and sent the result to the pipeline (because that’s what `Write-Output` does); because there was nothing else in the pipeline, the formatting system took over and created an onscreen display of whatever was in the pipeline (hopefully, 10).

That means your script should never use `Write-Output` for anything except your intended output. And your intended output should always be either nothing, if that’s appropriate, or some structured data—objects—that can be passed to another command.

`Write-Output` should never be used for little status messages that tell you what the script is doing. It should never output plain, preformatted text (unless that’s the output or result of your command). We’re going to walk through this output design process over the course of several chapters, but for right now, we want you to have in mind that *output matters* and that PowerShell’s foundational design has certain expectations for the output’s form and content.

10.1.1 Designing the input parameters

Looking back through the design, what information will the function need? The usage examples already provide pretty clear guidance about what parameters you’ll have to create, which is one reason you create usage examples as your primary design deliverable. Now, let’s create basic versions of those parameters:

```
function Get-MachineInfo {
 Param(
  [string[]]$ComputerName,
  [string]$LogFailuresToPath,
  [string]$Protocol = "wsman",
  [switch]$ProtocolFallback
```

```
)}
```

Notice how careful we're being with the formatting of this code? In order to conserve space in this book, we're only indenting the code a little within the function and within the `Param()` block, but you'll typically indent four spaces (which, in most code editors, is what the Tab key inserts). *Don't get lazy about your code formatting*. Lazy formatting is a sign of the devil and an indication of code that probably has bugs—and will be hard to debug.

TIP

Formating is important! VSCode will auto format your PowerShell document for you. Just `Format Document` into the command palate.

In the `Param()` block, you declare four parameters. These are simple declarations, and you'll build on them in upcoming chapters. For now, here are some things to notice:

- Data types are enclosed in square brackets. Common ones include `[string]`, `[int]`, and `[datetime]`. You'll notice `[switch]` here, which defines a para-meter that will contain `$True` if the command is run with the parameter or `$False` if not.
- Parameters become variables inside the function, meaning their names are preceded with a `$`. And for goodness' sake, don't try to create a parameter name with spaces!
- In the `Param()` section, each parameter is separated from the next with a comma. You don't *have* to put them one per line as we've done, but when you start building on these, it'll be a lot easier to read if they're broken out one per line.
- The `-ComputerName` parameter will accept zero or more values in an *array*, which is what `[string[]]` denotes.
- The `$Protocol` variable will contain "Wsman" unless someone explicitly specifies something else. Right now, you're not limiting a user's choices to "Wsman" or "Dcom," but you eventually will.

10.1.2 Writing the code

Now let's insert some basic functional code. Again, *this won't complete the*

tool’s entire mission—you’re just getting started, and we want to walk you through each step. We also encourage you to pay attention to the process and not necessarily the end result. All of our samples are intended to be educational, not necessarily the absolute best way to accomplish a task.

Listing 10.1 Basic functional code

```
function Get-MachineInfo {
 Param(
  [string[]]$ComputerName,
  [string]$LogFailuresToPath,
  [string]$Protocol = "Wsman",
  [switch]$ProtocolFallback
 )
 foreach ($computer in $computername) {       #A
  # Establish session protocol
  if ($protocol -eq 'Dcom') {                                #B
   $option = New-CimSessionOption -Protocol Dcom
  } else {
   $option = New-CimSessionOption -Protocol Wsman
  }
  # Connect session
  $session = New-CimSession -ComputerName $computer -SessionOptio
  # Query data
  $os = Get-CimInstance -ClassName Win32_OperatingSystem -CimSess
  # Close session
  $session | Remove-CimSession
  # Output data
  # TODO
 } #foreach
} #function      #C
```

TIP

Notice that we tagged a `#function` comment on the closing bracket of the function. That’s a good habit to get into when you have a closing bracket, because it can help remind you which construct the bracket closes. You should also learn the commands for your scripting editor of choice, to be able to find matching brackets. If your editor supports code folding, that too will be helpful. We see people run into more than a few bugs due to a missing or misplaced closing bracket.

The `If` construct will help prevent problems if someone specifies an illegal

protocol for the `-Protocol` parameter; if they specify “Dcom,” you’ll set up a Dcom session. Otherwise, if they specify anything else, you’ll go with a WSman session.

You’re querying only one of the classes that you’ll ultimately need to query; the point is to start simply, test, and then, once everything’s working, add more. This is a conservative coding approach; although it adds little development time, it will help you prevent complex bugs from creeping into the code. If you test as you go, then whenever a bug crops up, you’ll probably have only a couple of lines to debug.

10.1.3 Designing the output

Finally, you need to have the command output something.

Listing 10.2 Adding output

```
function Get-MachineInfo {
 Param(
  [string[]]$ComputerName,
  [string]$LogFailuresToPath,
  [string]$Protocol = "Wsman",
  [switch]$ProtocolFallback
 )
 foreach ($computer in $computername) {
  # Establish session protocol
  if ($protocol -eq 'Dcom') {
   $option = New-CimSessionOption -Protocol Dcom
  } else {
   $option = New-CimSessionOption -Protocol Wsman
  }
  $session = New-CimSession -ComputerName $computer -SessionOptio
  # Query data
  $os = Get-CimInstance -ClassName Win32_OperatingSystem -CimSess
➥ $session
  # Close session
  $session | Remove-CimSession
  # Output data
  $os | Select-Object -Prop @{n='ComputerName';e={$computer}},
                            Version,ServicePackMajorVersion     #
 } #foreach
} #function
```

This isn't especially complex output—you're just grabbing the computer name and the two OS properties you specified in the design. Eventually, this output will become more complex as you start adding queries to the mix and incorporating their properties into your output.

Note

Again, notice that you're outputting a data structure—an *object*—to the pipeline. You haven't explicitly used `Write-Output`, but it's implicitly there because you didn't assign the results of that expression to a variable, nor did you explicitly pipe your object anyplace else. You piped `$os` to `Select-Object`, and the result of that expression will end up in the pipeline.

10.2 Creating a script module

The last step will be to save all of this code as a *script module*. Modules can be saved in a variety of places but the best place is in the default directory for modules. You can find this listed in the PSModulePath environment variable (`$env:psmodulepath`). On Windows Powershelland later, that path by default includes C:\Program Files\WindowsPowerShell\Modules, and on On PowerShell v7 and later, that path by default includes C:\Program Files\WindowsPowerShell\7\\Modules so that's where you'll create the module, under a subfolder called ScriptingMOL. Specifically, save it as ScriptingMOL.psm1. Notice that the *subfolder name* and the *filename* must match in order for PowerShell to automatically discover the module and load it on demand.

TIP

Actually, when we're just playing around, we usually save our module to the path under the Documents folder. That makes it feel personal. We generally reserve the Program Files location for production modules that are ready to go. In this case, we want you to get used to that location existing and being where "real" modules go when you're finished with them.

We've included our module, such as it is at this point, in the code samples for this book (which are arranged by chapter and downloadable from

https://www.manning.com/books/learn-powershell-scripting-in-a-month-of-lunches). To load the module, you'll need to manually run `Import-Module` and provide the full path to the .psm1 file on your computer from the extracted zip file. That's because the code samples include multiple versions of the module, and you aren't installing the code samples in one of the locations where PowerShell automatically looks for modules. Providing the full path to `Import-Module` ensures that you're loading the right version of the module for your purposes. When you're finished, you should use `Remove-Module` (or close the console and open a new one) to ensure that you've cleaned up before trying to load a subsequent version of the same module. You can also use the `-Force` parameter with `Import-Module` to forcibly overwrite existing commands.

tip

Depending on how you download the zip file, its file header may be flagged, indicating that it came from the internet. Again, depending on how you unzip it, the individual files may also be flagged that way. Many PowerShell execution policies block downloaded files from running. Newer versions of PowerShell include an `Unblock-File` command, which removes that "downloaded" flag, clearing the script for execution (or for loading as a module).

10.3 Prereq check

Before you test the command, especially if you're planning to run it yourself and follow along, you need to check a few things:

- Make sure your PowerShell window always says Administrator in the title bar. If it doesn't, run the shell "as Administrator" by right-clicking the PowerShell Task Bar icon and selecting the appropriate option.
- Run `Get-ExecutionPolicy`; the result should be RemoteSigned, Bypass, or Unrestricted. If not, use `Set-ExecutionPolicy` to change the setting to one of those (we use Bypass, and we've covered in chapter 7 why you might pick one or another).
- Run `Get-CimInstance win32_service -computername localhost` to ensure that CIM is set up and working.

If any of these aren't confirmed on your system, *stop*. You'll need to fix them. We've covered the first two; the last item should be a problem only on older versions of Windows (pre-Windows 8), where CIM isn't enabled by default. You can usually correct this by installing a more recent version of PowerShell (v3 or later should do it), and you may need to restart afterward. But rest assured that if you don't get these three items working, pretty much nothing else in this book is going to work, either.

10.4 Running the command

Now for the real test. First, *close your PowerShell window*. That will ensure that the test is in a clean PowerShell environment. Then open a new one (make sure it's "as Administrator"), and run this command:

```
Get-MachineInfo -ComputerName localhost
```

No shortcuts

We're assuming that you've been following along and creating your own module from scratch, not just testing with our provided sample code. As we explained previously, just running `Get-MachineInfo` won't automatically work unless you've created a .psm1 file in the correct, magic location that PowerShell looks in, and our code samples will *not* be in the correct, magic location.

Don't try to take shortcuts here by running our samples—follow along and write your own code. It's the best way to learn.

You should get some output from running the command. In fact, you should be able to type `Get-Machi`, press Tab, type a space, type `–Comp`, press Tab, and then type a space and `localhost`. If Tab completion isn't working, double-check your script for proper filenames, any typos in the code (indicated in the PowerShell ISE or Visual Studio Code by red squiggly underlines), and so on. Also make sure you've used a path that's in your machine's PSModulePath environment variable:

```
$env:PSModulePath
```

If the command runs without trouble, then you're good to go. Take some time to make sure that you understand *why* each line of code is in the command and that you can explain the reason for each step you've performed to this point.

If you make any changes to your module, it's important to understand that PowerShell won't "see" those changes. That's because it loaded the module into memory when you first ran your command; afterward, it runs entirely from memory and doesn't reload from disk. So if you make any changes to your code, you need to do one of two things:

- Close the PowerShell console window in which you've been testing, and open a new one. This is a sure-fire way to make sure you get a fresh start every time. Unload your module, and then run your command again to reload the module. In this case, that means running `Remove-Module ScriptingMOL`, because ScriptingMOL is the module name (as defined by the subfolder name and the .psd1 filename).
- Try to manually force PowerShell to reimport the module with the command `Import-Module ScriptingMOL -force`.

You'll also notice that we tend to test our commands in a normal PowerShell console window, even though we're developing in something like the PowerShell ISE, Visual Studio Code, and so on. That's because development environments sometimes have a slightly different way of running scripts, and the console window represents the standard way your script will run in production. The console represents the production environment, so that's where we test.

10.5 Your turn

Let's return to the tool we asked you to design in chapter 8. It's time to start coding it up.

10.5.1 Start here

To review, you've designed the command name as Set-TMServiceLogon. The *TM* stands for *Toolmaking*, because you don't have a specific company

or organizational name to use. You’ll design the following use cases:

```
Set-TMServiceLogon -ServiceName LOBApp
                   -NewPassword "P@ssw0rd"
                   -ComputerName SERVER1,SERVER2
                   -ErrorLogFilePath failed.txt
                   -Verbose
```

The intent here is that `-Verbose` will generate onscreen warnings about failures, whereas `-ErrorLogFilePath` will write failed computer names to a file. Notice that, to make this specification easier to read, we’ve put each parameter on its own line. The command won’t *execute* exactly like that, but that’s fine—clarity is the idea at this point.

The following example illustrates that `-ErrorLogFilePath` and `-Verbose` are optional, as is `-NewUser`; if a new user isn’t specified, you’ll leave that property alone:

```
Set-TMServiceLogon -ServiceName OurService
                   -NewPassword "P@ssw0rd"
                   -NewUser "COMPANY\User"
                   -ComputerName SERVER1,SERVER2
```

We also want to show some flexible execution options:

```
Get-Content servers.txt |
➥ Set-TMServiceLogon -ServiceName TheService -NewPassword "P@ssw(
```

This illustrates your ability to accept computer names from the pipeline. Finally

```
Import-CSV tochange.csv | Set-TMServiceLogon | ConvertTo-HTML
```

We’re demonstrating two things here. First is that you can accept an imported CSV file, assuming it has columns named ServiceName, NewPassword, and ComputerName, and optionally NewUser. The output is also consumable by standard PowerShell commands like `ConvertTo-HTML`, which implies that `Format-` commands and `Export-` commands will also work.

10.5.2 Your task

Create a basic function named Set-TMServiceLogon. Specify all the parameters that are listed in the design, although right now you might not use all of them. Write enough code so that, given a computer name, service name, and new password, the function can change the password. If a new username is specified, that should be set as well. You’ll use both an `If` and a `ForEach` construct. Right now, make sure these two usage examples will work:

```
Set-TMServiceLogon -ServiceName OurService
                   -NewPassword "P@ssw0rd"
                   -NewUser "COMPANY\User"
                   -ComputerName SERVER1,SERVER2
Set-TMServiceLogon -ServiceName OurService
                   -NewPassword "P@ssw0rd"
                   -ComputerName SERVER1,SERVER2
```

Create the function in a script module named MolTools. Test your function against the BITS service on your local host. Remember, you should have run the necessary commands in the previous lab to discover the correct syntax. For now, assume that a WSman (CIM) connection is all you need to implement. Additionally, for now, don’t worry about logging or other features specified in the design.

Keep in mind what you learned from the previous chapter, regarding the output of `Invoke-CimMethod`. For now, it’s okay to output the computer name and its return code; you can create that output using `Select-Object` and custom properties, like you did in the Get-MachineInfo example. Later, you’ll work on getting the output closer to the design specification.

Test your command in the PowerShell console, rather than in the ISE or VS Code, and bear in mind the caveats we pointed out about unloading your module after making changes.

10.5.3 Our take

Here’s our solution for you to compare to your own. Minor variations shouldn’t be cause for concern, provided your command works when you run it.

Listing 10.3 Our solution

```
function Set-TMServiceLogon {
    Param(
        [string]$ServiceName,
        [string[]]$ComputerName,
        [string]$NewPassword,
        [string]$NewUser,
        [string]$ErrorLogFilePath
    )
    ForEach ($computer in $ComputerName) {
        $option = New-CimSessionOption -Protocol Wsman
        $session = New-CimSession -SessionOption $option `
                                  -ComputerName $Computer
        If ($PSBoundParameters.ContainsKey('NewUser')) {        #
            $args = @{'StartName'=$NewUser;
                      'StartPassword'=$NewPassword}
        } Else {
            $args = @{'StartPassword'=$NewPassword}
        }
        Invoke-CimMethod -ComputerName $computer `
                         -MethodName Change `
                         -Query "SELECT * FROM Win32_Service WHER
➥ '$ServiceName'" `
                         -Arguments $args |
        Select-Object -Property @{n='ComputerName';e={$computer}}
                                @{n='Result';e={$_.ReturnValue}}
        $session | Remove-CimSession
    } #foreach
} #function
```

Notice that we didn't include a `Verbose` parameter. That's intentional, and you'll see why in the next couple of chapters.

Also, notice our use of `$PSBoundParameters` to see whether the `NewUser` para-meter was specified. This is kind of a trick that we didn't expect you to know—you may have done something like `If ($NewUser -ne "")` or `if (-Not $NewUser)` to see whether `$NewUser` contains anything, and that's fine. `$PSBoundParameters` is a hash table containing all the parameters the command was run with. It's created automatically. You don't have to do anything. By using its `ContainsKey()` method, we can see whether `NewUser` is among the parameters used. This is considered a better way of testing to see whether a parameter is used. But you can see how the `If` construct is used to build the CIM arguments hash table, either with just a password or with a password and a new username. We're in trouble if someone doesn't specify a

new password, but we’ll deal with that possibility as we evolve the function.

In our CIM query (which may get truncated in the book; check the code samples to see the whole thing), we use PowerShell’s double-quotes trick to insert `$Service-Name` into the query. We pipe the result of `Invoke-CimMethod`—which, in the previous chapter, you learned returns an object having a `ReturnValue` property—to `Select-Object` so that we can construct our output.

We created a manifest for this, too:

```
New-ModuleManifest -Path TMTools.psd1
                   -RootModule .\TMTools.psm1
                   -FunctionsToExport Set-TMServiceLogon
                   -ModuleVersion 1.0.0.0
```

We’ve included our solution, to this point, in the code samples for this book, in the corresponding chapter folder (https://www.manning.com/books/learn-powershell-scripting-in-a-month-of-lunches). To load the module, you’ll need to manually run `Import-Module` and provide the full path to our .psd1 file on your computer. In the code samples for this chapter, the module name is MoLTools-Prelim, to avoid conflicting with the “real” MoLTools module that you’re building on your own.

Finally, be sure to reset the BITS service, as you did in the previous chapter, after testing your function.

11 Getting started with advanced functions

We are almost there, we promise, but before we can start writing our own advanced fuctnions In this chapter, we'll focus entirely on the `Param()` block of the example function and discuss some of the cool things you can do with it.

11.1 About CmdletBinding and common parameters

What is the difference between a simple function and an Advanced Function? It may surprise you to know that its just a single line of code. The `CmdletBinding()]` attribute. This attribute adds so much functionality. Lets take a look. To illustrate the first major difference, let's start with a basic function:

```
function test {
    Param(
    [string]$ComputerName
    )
}
```

That's it. No code at all. Now ask PowerShell for help with that function:

```
PS C:\> help test
NAME
    test
SYNTAX
    test [[-ComputerName] <string>]
ALIASES
    None
```

That's what we'd expect—PowerShell is producing the best help it can, given the complete nonexistence of anything. Now, let's make one change to the code:

```
function test {
    [CmdletBinding()]
    Param(
        [string]$ComputerName
    )
}
```

and again ask for help:

```
PS C:\> help test
NAME
    test
SYNTAX
    test [[-ComputerName] <string>]  [<CommonParameters>]
ALIASES
    None
```

Buy adding the `[CmdletBinding()]` attribute PowerShell added the common parameters to our function. If you read the `about_CommonParameters` help file, you'll discover that *all PowerShell commands* support this set of parameters. The number has grown through the subsequent versions of PowerShell, and there are now 11 parameters. Cmdlet authors don't need to do anything to make these work—Power-Shell takes care of everything. And because we added `[CmdletBinding()]`, the function will support all of these common parameters as well. Some of the cooler ones (with availability differing based on your version of PowerShell) include the following:

- `-Verbose`—Enables the output of `Write-Verbose` in your function, overriding the global `$VerbosePreference` variable.
- `-Debug`—Enables the use of `Write-Debug` in your function.
- `-ErrorAction`—Modifies your function's behavior in the event of an error, and overrides the global `$ErrorActionPreference` variable.
- `-ErrorVariable`—Lets you specify a variable name in which PowerShell will capture any errors your function generates.
- `-InformationAction`—Overrides the global `$InformationPreference` variable, and enables `Write-Information` output. This was added in PowerShell v5.
- `-InformationVariable`—Specifies a variable in which output from `Write-Information` will be captured. This too was added in PowerShell v5.

- `-OutVariable`—Specifies a variable in which PowerShell will place copies of your function's output, while also sending copies into the main pipeline. We'll cover this more in chapter 15.
- `-PipelineVariable`—Specifies a variable, in which PowerShell will store a copy of the current pipeline element. We'll cover this more in our chapter on troubleshooting.

There are others, and we'll discuss almost all of them in more detail in upcoming chapters.

11.1.1 Accepting pipeline input

If you remember the original design for the example tool, we specified a need to capture input from the pipeline. This requires a modification both to the parameters and to the code of the function. As a reminder, listing 11.1 shows where you're starting after the previous chapter, and listing 11.2 gives the modified function.

If you remember the original design for the example tool, we specified a need to capture input from the pipeline. This requires a modification both to the parameters and to the code of the function. As a reminder, listing 11.1 shows where you're starting after the previous chapter, and listing 11.2 gives the modified function.

Listing 11.1 Original Get-MachineInfo function

```
function Get-MachineInfo {
    Param(
        [string[]]$ComputerName,
        [string]$LogFailuresToPath,
        [string]$Protocol = "Wsman",
        [switch]$ProtocolFallback
    )
    foreach ($computer in $computername) {
        if ($protocol -eq 'Dcom') {                 #A
            $option = New-CimSessionOption -Protocol Dcom
        } else {
            $option = New-CimSessionOption -Protocol Wsman
        }
        $session = New-CimSession -ComputerName $computer    #B
       ➥ -SessionOption $option
```

```
        #
        $os = Get-CimInstance -ClassName Win32_OperatingSystem
        ➥ -CimSession $session
        $session | Remove-CimSession
        $os | Select-Object -Prop @{n='ComputerName';e={$computer
                                Version,ServicePackMajorVersion
    } #foreach
} #function
```

Listing 11.2 Modified Get-MachineInfo

```
function Get-MachineInfo {
    [CmdletBinding()]                               #A
    Param(
        [Parameter(ValueFromPipeline=$True)]     #B
        [string[]]$ComputerName,
        [string]$LogFailuresToPath,
        [string]$Protocol = "Wsman",
        [switch]$ProtocolFallback
    )
 BEGIN {}                                 #C
 PROCESS {
    foreach ($computer in $computername) {
        # Establish session protocol
        if ($protocol -eq 'Dcom') {
            $option = New-CimSessionOption -Protocol Dcom
        } else {
            $option = New-CimSessionOption -Protocol Wsman
        }
        # Connect session
        $session = New-CimSession -ComputerName $computer `
                                  -SessionOption $option
        # Query data
        $os = Get-CimInstance -ClassName Win32_OperatingSystem `
                              -CimSession $session
        # Close session
        $session | Remove-CimSession
        # Output data
        $os | Select-Object -Prop @{n='ComputerName';e={$computer
                                Version,ServicePackMajorVersion
    } #foreach
} #PROCESS
END {}
} #function
```

Here’s what we did:

- We added `[CmdletBinding()]` to the `Param()` block.
- We used blank lines to visually separate the parameters in the `Param()` block.
- We added a `[Parameter()]` *decorator*, or *attribute*, to the `$ComputerName` para-meter. Although we physically placed it on the preceding line, PowerShell will read those two lines as one.
- In the decorator, we specified that the `$ComputerName` parameter is capable of accepting values (`[string]` values, to be specific, because that's what the parameter is) from the pipeline.
- We added `BEGIN{}`, `PROCESS{}`, and `END{}` script blocks.

Understanding how all this fits together requires you to remember that you want the function to run in two distinct modes and that each mode has slightly different requirements from PowerShell.

Running commands in non-pipeline mode

Imagine running the command like this:

```
Get-MachineInfo -ComputerName ONE,TWO,THREE
```

In this mode, PowerShell will ignore the `BEGIN{}`, `PROCESS{}`, and `END{}` *labels*, but it won't ignore the *code within those labels*. In other words, it's like the labels never existed. `$ComputerName` will contain an array, or collection, of three `[string]` objects: "ONE", "TWO", and "THREE". The entire command will run one time, from the first line of code to the last. The `ForEach` loop will execute three times.

Running commands in pipeline mode

Now, imagine running the command this way:

```
"ONE","TWO","THREE" | Get-MachineInfo
```

First, PowerShell will construct a three-element array, because that's what comma-separated lists do in PowerShell. It will then scan ahead in the pipeline and execute the `BEGIN{}` block for each command in the pipeline. That's true for both advanced functions and compiled cmdlets. The Begin

block (which doesn't *have* to be in all-uppercase, and which can be omitted if you don't have any code to stick in there) is a good place to do setup tasks, such as opening database connections, setting up log files, or initializing arrays. Any variables you create in the Begin block will continue to exist elsewhere in your function.

Next, PowerShell will start feeding the elements from that three-element array down the pipeline, *one at a time*. So, it will insert "ONE" into `$ComputerName` and then run the `PROCESS{}` block. The `ForEach` loop will execute, but only once—it's kind of redundant in this mode, but we need it for the non-pipeline mode. PowerShell will then feed "TWO" into `$ComputerName` and run `PROCESS{}` again. It'll then put "THREE" into `$ComputerName` and run `PROCESS{}` one last time.

Finally, after all the objects have been sent through the pipeline, PowerShell will rescan the pipeline and ask everyone to run their `END{}` blocks. Again, you can omit this if you don't have anything to put in there, but for visual purposes we like to include it even if it's empty. One suggestion is to insert a comment into empty Begin and End blocks so you don't think something is missing:

```
End {
 # intentionally empty
}
```

Values and PropertyNames

Notice that the example uses this decorator:

```
[Parameter(ValueFromPipeline=$True)]
```

This enables ByValue binding of pipeline input. You can enable this for only one parameter per data type. Because `$ComputerName` is a `[string]`, it's therefore the only `[string]` parameter we can mark as accepting pipeline input ByValue.

You can also enable input ByPropertyName:

```
[Parameter(ValueFromPipeline=$True,ValueFromPipelineByPropertyNam
```

Now, if the object in the pipeline isn't a `System.String`, but it has a `ComputerName` *property*, the `$ComputerName` variable will pick that up as well.

If you're not deeply familiar with pipeline parameter input ByValue and ByProperty-Name, we urge you to read *Learn Windows PowerShell in a Month of Lunches* and learn all about it. It's a crucial feature in Windows PowerShell.

11.1.2 Mandatory-ness

Because the function can't run correctly without a computer name, you want to ensure that at least one is always provided. Here's the revised set of parameters:

```
Param(
    [Parameter(ValueFromPipeline=$True,
               Mandatory=$True)]
    [string[]]$ComputerName,
    [string]$LogFailuresToPath,
    [string]$Protocol = "Wsman",
    [switch]$ProtocolFallback
)
```

Some notes on our decision-making process:

- Making `$ComputerName` mandatory makes sense. If a value isn't provided, Power-Shell will prompt for it and then fail with an error if one still isn't given. It's important to remember that if you make a parameter mandatory, you can't also provide a default value, as we do with the `Protocol` parameter.
- Making `$LogFailuresToPath` mandatory doesn't make sense, because you don't want to force people to log errors. We'll check to see if this is provided, and enable logging accordingly.
- Although `$Protocol` is technically mandatory, we're providing a default value of "Wsman", so there's no need to force people to manually provide a value, which is what `Mandatory=$True` would do. We're happy with someone not specifying a protocol, because we have a useful default value.

- You never make a `[switch]` parameter mandatory, because you're essentially forcing it to be $True (or forcing someone to run `-ProtocolFallback:$false` to turn it off, which is awkward).
- You can make as many parameters mandatory as you require.

11.1.3 Parameter validation

The `$Protocol` parameter has a weakness in that it'll accept any string whatsoever. The code is a little protected from incorrect values, due to the way the `If` construct is written, but it'd be nice to prevent incorrect values altogether. It'd also be nice to provide users with a clue as to what the valid values are. You can do both in one step:

```
[CmdletBinding()]
Param(
    [Parameter(ValueFromPipeline=$True,
               Mandatory=$True)]
    [string[]]$ComputerName,
    [string]$LogFailuresToPath,
    [ValidateSet('Wsman','Dcom')]
    [string]$Protocol = "Wsman",
    [switch]$ProtocolFallback
)
```

Here, you add a `[ValidateSet()]` attribute to the `$Protocol` parameter. PowerShell will now disallow any values not in the list, display valid values in the help it automatically generates, and even Tab-complete those values for users. There are other validation methods available; read `about_functions_advanced_parameters` for a full list.

11.1.4 Parameter aliases

Finally, although you've followed native PowerShell patterns in using `-ComputerName` as a parameter name, you might also find value in this addition:

```
[CmdletBinding()]
Param(
    [Parameter(ValueFromPipeline=$True,
               Mandatory=$True)]
```

```
    [Alias('CN','MachineName','Name')]
    [string[]]$ComputerName,
    [string]$LogFailuresToPath,
    [ValidateSet('Wsman','Dcom')]
    [string]$Protocol = "Wsman",
    [switch]$ProtocolFallback
)
```

Here, you define three aliases for the parameter, making `-CN`, `-MachineName`, and `-Name` valid alternatives.

Going further

Parameters can get almost infinitely complex, especially as you move into the more cutting-edge features of newer versions of PowerShell. Although we've covered those in more advanced books (*PowerShell in Depth, The PowerShell Scripting & Toolmaking Book*), we don't cover them here because they're outside the realm of "getting started with toolmaking" that this book focuses on.

That said, we do want you to be aware of the possibilities!

One thing you can do is define multiple *parameter sets*. Parameter sets often share certain parameters that are common to all of them, while reserving other parameters for mutually exclusive sets. Your `CmdletBinding` attribute can even define which set is the default.

Another topic—and one that could almost be its own book—is *dynamic parameters*. These are parameters that magically come into existence—or go out of existence—based on the exact situation in which the command finds itself at the time. You might expose certain parameters when a command is in a local disk drive but hide them when it's in a network drive. The possibilities are nearly limitless, making these things pretty tricky to work with.

PowerShell's parameters provide a ton of depth to support a wide range of sophisticated scenarios. When you've mastered the basics that we've covered here, you'll be ready to explore even further.

11.1.5 Supporting –Confirm and –WhatIf

There are two more additional pieces of functionality that come with the `[CmdletBinding()]` attribute. And those are the `-WhatIf` and `-Confrim` parameters. Lets step out of our running example for a moment and discuss these often-misunderstood, but deeply valuable, option. Consider this parameter block:

```
Function Set-Something {
  [CmdletBinding(SupportsShouldProcess=$True,ConfirmImpact='Low')
  Param(
  )
} #function
```

The `CmdletBinding` attribute has gotten a bit more complex. It has declared that it supports Should Process, a PowerShell feature that will enable the `–WhatIf` and `–Confirm` parameters for the function. This is appropriate for functions that plan to make some kind of change to the system. If someone runs our command with `–WhatIf`, and we've taken the proper steps, then the command won't do anything—it'll just show what it would have done, had we let it. Or, if someone runs the command with `–Confirm`, and we've again taken the proper steps in the code, then PowerShell will ask the user to confirm each operation, essentially asking them, "Are you sure?"

It's worth noting that the `–WhatIf` and `–Confirm` switches are inherited by commands inside our function. That is, we don't have to do *anything* if all we're doing is running some other command that itself supports `–WhatIf` and `–Confirm`. Running *our* function with one or both of those parameters will pass them through to the commands inside. But suppose we want to run some command that doesn't support `–WhatIf` and `–Confirm`—maybe a raw .NET Framework class that might blow up the system:

```
Function Invoke-InfoTechExplosion {
  [CmdletBinding(SupportsShouldProcess=$True,ConfirmImpact='Low')
  Param(
    [Parameter(Mandatory=$True)]
    [string[]]$DomainNameToCrash
  )
  ForEach ($Domain in $DomainNameToCrash) {
    If ($PSCmdlet.ShouldProcess($Domain)) {
      [System.Directory]::GetDomain($Domain).Destroy()
    }
  }
```

```
} #function
```

This example is obviously all in fun, but you hopefully get the idea. When we call `$PSCmdlet.ShouldProcess()`and pass a description of what we're about to target, here's what PowerShell does:

- If the command wasn't run with either `-WhatIf` or `-Confirm`, then the method returns True, and whatever we've put inside the `If` construct runs.
- If the command was run with `-WhatIf`, a message is displayed, the method returns False, and our dangerous code never runs.
- If the command was run with `-Confirm`, a prompt is produced, and the method returns True or False based on the response to that prompt, determining whether our dangerous code runs or not.

The `ConfirmImpact` setting plays into the built-in `$ConfirmPreference` variable in the shell, which defaults to "High." We can specify "Low," "Medium," or "High." Here's the deal: If the specified `ConfirmImpact` setting is *equal to or greater than* the content of `$ConfirmPreference`, then the `-Confirm` parameter is automatically used, even if we don't explicitly type it.

As a best practice, you should support the Should Process feature in any command that might modify the system. Typically, commands with a *Get* verb wouldn't do that, but commands like *Set*, *Invoke*, *Remove*, *Add,* and so on might—and should support this feature set. If you're providing comment-based help with your command (which we'll discuss in a bit), you don't need to document `-WhatIf` and `-Confirm`; they'll be automatically documented for you.

As a secondary best practice, *don't* declare support for Should Process unless you *implement* that support. As we've noted, sometimes you don't need to do anything other than let `-WhatIf` or `-Confirm` fall through to the commands you're already running. But *test that*—nothing is more dangerous than someone running your command with `-WhatIf`, only to discover that you coded it wrong, and whatever dangerous thing your command did *actually happened* Whoops.

11.2 Your turn

Okay, let’s return to the command you built in the previous chapter, and start making some improvements.

11.2.1 Start here

Here’s where *we* finished up after the last chapter. You can either use this as a starting point or use your own lab result.

Listing 11.3 Set-TMServiceLogon

```
function Set-TMServiceLogon {
    Param(
        [string]$ServiceName,
        [string[]]$ComputerName,
        [string]$NewPassword,
        [string]$NewUser,
        [string]$ErrorLogFilePath
    )
    ForEach ($computer in $ComputerName) {
        $option = New-CimSessionOption -Protocol Wsman
        $session = New-CimSession -SessionOption $option `
                                  -ComputerName $Computer
        If ($PSBoundParameters.ContainsKey('NewUser')) {
            $args = @{'StartName'=$NewUser;
                      'StartPassword'=$NewPassword}
        } Else {
            $args = @{'StartPassword'=$NewPassword}
        }
        Invoke-CimMethod -ComputerName $computer `
                         -MethodName Change `
                         -Query "SELECT * FROM Win32_Service WHER
➥ '$ServiceName'" `
                         -Arguments $args |
        Select-Object -Property @{n='ComputerName';e={$computer}}
                                @{n='Result';e={$_.ReturnValue}}
        $session | Remove-CimSession
    } #foreach
} #function
```

11.2.2 Your task

Go ahead and make this an advanced function, and accomplish the following:

- Ensure that ServiceName, ComputerName, and NewPassword are mandatory. Don't make NewUser mandatory.
- Ensure that ComputerName can accept pipeline input ByValue.
- Ensure that ServiceName, ComputerName, NewPassword, and NewUser can accept pipeline input ByPropertyName.

11.2.3 Our take

Listing 11.4 shows what we came up with. Notice especially the `PROCESS{}` label addition in the body of the code.

NOTE

We didn't implement ShouldProcess here, although, because this command is modifying the system, we probably should. Notice that our change is being made by using `Invoke-CimMethod`. Does *it* support ShouldProcess? That is, does it support `–WhatIf` and `–Confirm`? If so, what would we need to do to pass that through from our command? Give it a try as a bonus exercise, and see if you can figure it out!

Listing 11.4 Modified Set-TMServiceLogon

```
function Set-TMServiceLogon {
    [CmdletBinding()]
    Param(
        [Parameter(Mandatory=$True,
                   ValueFromPipelineByPropertyName=$True)]
        [string]$ServiceName,
        [Parameter(Mandatory=$True,
                   ValueFromPipelineByPropertyName=$True,
                   ValueFromPipeline=$True)]
        [string[]]$ComputerName,
        [Parameter(Mandatory=$True,
                   ValueFromPipelineByPropertyName=$True)]
        [string]$NewPassword,
        [Parameter(ValueFromPipelineByPropertyName=$True)]
        [string]$NewUser,
        [string]$ErrorLogFilePath
    )
```

```
BEGIN{}
PROCESS{
    ForEach ($computer in $ComputerName) {
        $option = New-CimSessionOption -Protocol Wsman
        $session = New-CimSession -SessionOption $option `
                                  -ComputerName $Computer
        If ($PSBoundParameters.ContainsKey('NewUser')) {
            $args = @{'StartName'=$NewUser
                      'StartPassword'=$NewPassword}
        } Else {
            $args = @{'StartPassword'=$NewPassword}
        }
        Invoke-CimMethod -ComputerName $computer `
                         -MethodName Change `
                         -Query "SELECT * FROM Win32_Service WHER
➥ '$ServiceName'" `
                         -Arguments $args |
        Select-Object -Property @{n='ComputerName';e={$computer}}
                                @{n='Result';e={$_.ReturnValue}}
        $session | Remove-CimSession
    } #foreach
} #PROCESS
END{}
} #function
```

We’ve included our solution, to this point, in the code samples for this book at www.manning.com/books/learn-powershell-scripting-in-a-month-of-lunches.

Finally, be sure to reset the BITS service, as you did in the previous chapter, after testing your function. You really don’t want the BITS service messed up!

12 Objects: The best kind of output

Remember back in Chapter 8 when we created our initial design for `Get-MachineInfo`? So far we are querying for some information but not everything we want it to do. That was a deliberate decision we made so that you could get some structure around the tool first. We've also held off because once you start querying a bunch of information, you need to take a specific approach to combine it, and we wanted to tackle that approach in a single chapter.

Right now, the "functional" part of the tool looks like this:

```
# Query data
$os = Get-CimInstance -ClassName Win32_OperatingSystem `
                      -CimSession $session
# Close session
$session | Remove-CimSession
# Output data
$os | Select-Object -Prop @{n='ComputerName';e={$computer}},
                        Version,ServicePackMajorVersion
```

We are using `Select-Object` to produce the pieces of output we want. Some might call this the lazy way but we are just reducing the information we gathered, which someone could have done entirely on their own. Let's go back to the list of the information we originally wanted, and add where we'll get the information from:

- Computer hostname (you have this from the parameter).
- Manufacturer (`Win32_ComputerSystem`).
- Model (`Win32_ComputerSystem`).
- OS version and build number (`Win32_OperatingSystem`; `Version` and `BuildNumber`).
- Service pack version, if any (`Win32_OperatingSystem`; `ServicePackMajor-Version`).
- Installed RAM (`Win32_ComputerSystem`; `TotalPhysicalMemory` is in bytes).
- Processor type (`Win32_Processor`; `AddressWidth` is either 32 or 64).

- Processor socket count (`Win32_ComputerSystem`; `NumberOfProcessors`).
- Total core count (`Win32_ComputerSystem`; `NumberOfLogicalProcessors`).
- Free space on the system drive (usually C: but not always). This one's harder. `Win32_OperatingSystem` has a `SystemDrive` property that's something like "C:"; you'd need to query `Win32_LogicalDisk`, where the `DeviceId` property matches, and then look at its `FreeSpace`, which is in bytes.

Now let's start assembling that information.

12.1 Assembling the information

We're going to move away from using backticks in some places to keep the code's column width under the 80-character count that fits well in this book. Instead, we'll start using a technique called *splatting*. With this technique, you construct a hash table whose keys are parameter names and whose values are the corresponding parameter values. You can call the hashtable variable anything you'd like. We tend to use a meaningful name Here's an example:

```
$params = @{'ClassName'='Win32_OperatingSystem'
            'ComputerName'='CLIENT1'}
```

Put each parameter on a new line. For switch parameters, assign a value of `$True`:

```
$params = @{'ClassName'='Win32_OperatingSystem'
            'ComputerName'='CLIENT1'
            'Verbose' = $True}
```

You then feed those values to the command by prefixing the variable name with `@` instead of `$`:

```
Get-CimInstance @params
```

There, now you can tell your family you splatted today!

So here's the revised chunk of code that queries the information you need into variables:

```
# Query data
$os_params = @{'ClassName'='Win32_OperatingSystem'
               'CimSession'=$session}
$os = Get-CimInstance @os_params
$cs_params = @{'ClassName'='Win32_ComputerSystem'
               'CimSession'=$session}
$cs = Get-CimInstance @cs_params
$sysdrive = $os.SystemDrive                            #A
$drive_params = @{'ClassName'='Win32_LogicalDisk'
                  'Filter'="DeviceId='$sysdrive'"
                  'CimSession'=$session}
$drive = Get-CimInstance @drive_params
$proc_params = @{'ClassName'='Win32_Processor'
                 'CimSession'=$session}
$proc = Get-CimInstance @proc_params |
        Select-Object -first 1                     #B
```

A couple of notes

- Notice where you're getting the system drive letter into `$sysdrive` and then using `$sysdrive` as part of a filter in `Get-CimInstance`. This will ensure that `$drive` contains only one object.
- Also notice that you're using `Select-Object` to ensure that `$proc` contains only one object, too. It's not possible for the processors in a computer to have a different `AddressWidth`, so limiting the query to one result will make that result a bit easier to work with as you assemble information.

12.2 Constructing and emitting output

What you *want to avoid doing* at this point is output *text*. You should never use `Write-Host` for tool output because that output is sent to the information stream and spit out to the console. You couldn't reuse, redirect, or re-anything that output, which is the opposite of the point of a reusable tool. Instead, your tools should *always* output structured data in the form of objects, the way PowerShell commands were designed to do:

```
# Output data
$props = @{'ComputerName'=$computer
           'OSVersion'=$os.version
           'SPVersion'=$os.servicepackmajorversion
           'OSBuild'=$os.buildnumber
```

```
            'Manufacturer'=$cs.manufacturer
            'Model'=$cs.model
            'Procs'=$cs.numberofprocessors
            'Cores'=$cs.numberoflogicalprocessors
            'RAM'=($cs.totalphysicalmemory / 1GB)
            'Arch'=$proc.addresswidth
            'SysDriveFreeSpace'=$drive.freespace}
$obj = New-Object -TypeName PSObject -Property $props
Write-Output $obj
```

Again, some notes

- You're constructing a hash table in the `$props` variable—not unlike when splatting—that holds your output. Each key in the hash table is a property name you want to output, and each value is the corresponding data for that property.
- We've used shorter property names for the output than we usually would, mainly to help the code fit into this book. For example, we'd generally use *Architecture* instead of *Arch* because it's more straightforward. The hash table key will eventually become the property name. You should not try to use names with spaces, and names with underscores (_) look amateurish.
- You use `New-Object` to construct a blank object and attach your properties and values from the hash table.
- You don't *need* to save the object in `$obj` at this point. But we tend to do that because later, you'll modify the object, so it's useful to have it in a variable.
- You output the object *immediately* to the pipeline, using `Write-Output`, rather than accumulating it in an array or something to output later. The whole point of the pipeline is to accumulate objects for you and pass them on to whatever's next in the pipeline.

12.3 A quick test

After importing the module and running the command, we got the following output:

```
Arch                : 64
Manufacturer        : VMware, Inc.
ComputerName        : localhost
```

```
RAM                : 3.9995002746582
OSVersion          : 10.0.14393
Procs              : 1
SPVersion          : 0
Cores              : 1
Model              : VMware Virtual Platform
SysDriveFreeSpace : 46402207744
OSBuild            : 14393
```

Notice that *these properties aren't in the right order!* That's because we used a normal hash table to construct the property list, and .NET memory optimizes that storage, which can result in reordering. *That's fine*. At this level of a tool, you shouldn't be worried about what the output looks like—you could always use a `Format` command, or `Select-Object`, to specify an order. It *is* possible to construct an `[ordered]` hash table instead, but we rarely do so. Worrying about the raw output of a script is counterproductive and counter to native PowerShell patterns. Swallow your OCD, and let the output fall where it may!

Note

We deliberately left `SysDriveFreeSpace` in bytes, because it'll be useful for showing you another trick later.

Here's the code.

Listing 12.1 Get-MachineInfo

```
function Get-MachineInfo {
    [CmdletBinding()]
    Param(
        [Parameter(ValueFromPipeline=$True,
                   Mandatory=$True)]
        [Alias('CN','MachineName','Name')]
        [string[]]$ComputerName,
        [string]$LogFailuresToPath,
        [ValidateSet('Wsman','Dcom')]
        [string]$Protocol = "Wsman",
        [switch]$ProtocolFallback
    )
 BEGIN {}
 PROCESS {
```

```
        foreach ($computer in $computername) {
            # Establish session protocol
            if ($protocol -eq 'Dcom') {
                $option = New-CimSessionOption -Protocol Dcom
            } else {
                $option = New-CimSessionOption -Protocol Wsman
            }
            # Connect session
            $session = New-CimSession -ComputerName $computer `
                                      -SessionOption $option
            # Query data
            $os_params = @{'ClassName'='Win32_OperatingSystem'
                           'CimSession'=$session}
            $os = Get-CimInstance @os_params
            $cs_params = @{'ClassName'='Win32_ComputerSystem'
                           'CimSession'=$session}
            $cs = Get-CimInstance @cs_params
            $sysdrive = $os.SystemDrive
            $drive_params = @{'ClassName'='Win32_LogicalDisk'
                              'Filter'="DeviceId='$sysdrive'"
                              'CimSession'=$session}
            $drive = Get-CimInstance @drive_params
            $proc_params = @{'ClassName'='Win32_Processor'
                             'CimSession'=$session}
            $proc = Get-CimInstance @proc_params |
                    Select-Object -first 1
            # Close session
            $session | Remove-CimSession
            # Output data
            $props = @{'ComputerName'=$computer
                       'OSVersion'=$os.version
                       'SPVersion'=$os.servicepackmajorversion
                       'OSBuild'=$os.buildnumber
                       'Manufacturer'=$cs.manufacturer
                       'Model'=$cs.model
                       'Procs'=$cs.numberofprocessors
                       'Cores'=$cs.numberoflogicalprocessors
                       'RAM'=($cs.totalphysicalmemory / 1GB)
                       'Arch'=$proc.addresswidth
                       'SysDriveFreeSpace'=$drive.freespace}
            $obj = New-Object -TypeName PSObject -Property $props
            Write-Output $obj
        } #foreach
    } #PROCESS
    END {}
    } #function
```

12.4 An object alternative

By this point in the book, we hope you've gotten the memo that PowerShell is all about the objects. Using `New-Object,` as we've demonstrated, is useful. But as an alternative, you can also use a type accelerator, `[pscustomobject]`. You can use this in front of a hash table definition, and PowerShell will create a custom object, just as if you'd used `New-Object`:

```
[pscustomobject]@{
Name = 'James'
Department = 'IT'
Computername = 'Laptop-QTP097'
Expires = (Get-Date).AddDays(90)
}
```

This will create an object as follows:

```
Name  Department Computername  Expires
----  ---------- ------------  -------
James IT         Laptop-QTP097 3/30/2023 1:23:33 PM
```

We find it handy to use `[pscustomobject]` in the console when testing pipeline binding because we can create a simple object on the fly:

```
[pscustomobject]@{Name='bits';computername='Laptop-256'} | get-se
```

As an added bonus, the type accelerator will use the hash table as an ordered hash table. This means your property names will be displayed in the order you list them. As we said earlier, this is something you shouldn't worry too much about, but sometimes it comes in handy.

Now, the question we hope you're asking is, "Which technique do I use?" Using a cmdlet like `New-Object` is probably preferred because if someone new to PowerShell is looking at your code, they can get help for `New-Object`. Because you're using full parameter names, the syntax is more intuitive. Using `[pscustomobject]` can make your code a little more cryptic, but if you insert a comment explaining what you're doing, there's probably nothing wrong with using it.

12.5 Enriching objects

In the running example so far, you're using custom objects to combine information from other objects you've obtained. That's not the only use case in which you'll find yourself, though, and so we wanted to briefly step out of the running example and explore a different scenario.

Suppose for a moment that you're writing a command to retrieve from Active Directory computer accounts that match provided filter criteria. Your goal is to produce all of the original information that Active Directory has for each computer account, but you want to also return the Windows build number that each computer is running—at least, for those computers that are online and that you have permission to query.

You *could* follow the exact same model we've followed thus far and create a brand-new object that contains the combined information. But those Active Directory computer objects have a *lot* of properties, which would require a *lot* of code to copy over. And all you want to do is add one teeny widdle property…. Can't you just add it to the existing computer object?

Yup. Check out the following listing.

Listing 12.2 Add-ADComputerWindowsBuild function

```
function Add-ADComputerWindowsBuild {
    [CmdletBinding()]
    Param(
        [Parameter(ValueFromPipeline=$True)]
        [object[]]$InputObject
    )
    PROCESS {
        ForEach ($comp in $inputobject) {
            $os = Get-CimInstance -ComputerName $comp.name `
                                  -Class Win32_OperatingSystem
            $comp | Add-Member -MemberType NoteProperty `
                               -Name OSBuild `
                               -Value $os.BuildNumber
        } #foreach
    } #process
} #function
```

This is pretty bare-bones—we haven't dealt with a situation where a computer isn't online, for example. The key functionality here is the `Add-Member` cmdlet. When you pipe an object to it, it lets you add a property. In this case, we're adding a `Note-Property`, a static value. We've named the new property `OSBuild and populated it with the operating system build number` we just queried from CIM. `Add-Member` automatically modifies the object and then passes it through the pipeline. Because we didn't "capture" that output, it winds up becoming the output of the function. We'd run this like so:

```
Get-ADComputer –filter * |
Add-ADComputerWindowsBuild
```

We're still using the core `Get-ADComputer` command to do what it does best; we're just piping that to a second command that enriches the objects by adding new information to them. Again, not much different from producing a new object and copying whatever we want to it; but in this case, adding one thing is a lot easier than copying dozens or hundreds of things. This add-a-member technique can also be *faster* because you're not having to produce a new object and copy a bunch of data.

We'll point out, however, that from a purist software development perspective, what we've done is probably horrifying. Objects (well, more properly, *classes*, which define what a class looks like) are meant to be *contracts*. They're fixed, unchanging, and reliable. By tacking stuff on as we've done, we've—well, maybe not *broken* the contract, but indeed scribbled with a crayon in the margins. But it's okay—PowerShell's Extensible Type System (ETS, the thing that makes `Add-Member` work) was *designed* for this purpose. PowerShell enriches objects of all kinds every day, and you've probably never even noticed. So, use this technique when it helps you solve your problems!

12.6 Your turn

As with the previous chapters, let's focus on the service-changing tool. You may be thinking, "That tool doesn't produce any output!" but you'd be wrong. If you revisit the original design, you *do* want it to produce output for

each computer, success or fail. Right now, you’re probably just producing a minimal set of output using `Select-Object`:

```
Select-Object -Property @{n='ComputerName';e={$computer}},
@{n='Result';e={$_.ReturnValue}}
```

But that’s about to change!

12.6.1 Start here

Here’s where we left off with our version of this function. Use this, or your own work from the previous chapter, as a starting point.

Listing 12.3 Set-TMServiceLogon

```
function Set-TMServiceLogon {
    [CmdletBinding()]
    Param(
        [Parameter(Mandatory=$True,
                   ValueFromPipelineByPropertyName=$True)]
        [string]$ServiceName,
        [Parameter(Mandatory=$True,
                   ValueFromPipeline=$True,
                   ValueFromPipelineByPropertyName=$True)]
        [string[]]$ComputerName,
        [Parameter(ValueFromPipelineByPropertyName=$True)]
        [string]$NewPassword,
        [Parameter(ValueFromPipelineByPropertyName=$True)]
        [string]$NewUser,
        [string]$ErrorLogFilePath
    )
BEGIN{}
PROCESS{
    ForEach ($computer in $ComputerName) {
        $option = New-CimSessionOption -Protocol Wsman
        $session = New-CimSession -SessionOption $option `
                                  -ComputerName $Computer
        If ($PSBoundParameters.ContainsKey('NewUser')) {
            $args = @{'StartName'=$NewUser
                      'StartPassword'=$NewPassword}
        } Else {
            $args = @{'StartPassword'=$NewPassword}
        }
        Invoke-CimMethod -ComputerName $computer `
```

```
                         -MethodName Change `
                         -Query "SELECT * FROM Win32_Service WHER
➥'$ServiceName'" `
                         -Arguments $args |
        Select-Object -Property @{n='ComputerName';e={$computer}}
                                @{n='Result';e={$_.ReturnValue}}
        $session | Remove-CimSession
    } #foreach
} #PROCESS
END{}
} #function
```

12.6.2 Your task

Modify your function to output an object for each computer it operates against. The output should include the computer name and status. Revisit the status codes at http://mng.bz/c05L, and make it so that 0 displays “Success” in your output, 22 displays “Invalid Account,” and anything else displays “Failed: *XX*,” where *XX* is the numeric return value. As a challenge, try not to add more `If` constructs to your code—look into the `Switch` construct instead. It would be best if you also looked for places where you can use splatting.

12.6.3 Our take

Here’s our version (remember, you can get the code file in the downloadable samples).

Listing 12.4 Our version of Set-TMServiceLogon

```
function Set-TMServiceLogon {
    [CmdletBinding()]
    Param(
        [Parameter(Mandatory=$True,
                   ValueFromPipelineByPropertyName=$True)]
        [string]$ServiceName,
        [Parameter(Mandatory=$True,
                   ValueFromPipeline=$True,
                   ValueFromPipelineByPropertyName=$True)]
        [string[]]$ComputerName,
        [Parameter(ValueFromPipelineByPropertyName=$True)]
        [string]$NewPassword,
        [Parameter(ValueFromPipelineByPropertyName=$True)]
```

```
        [string]$NewUser,
        [string]$ErrorLogFilePath
    )
BEGIN{}
PROCESS{
    ForEach ($computer in $ComputerName) {
        $option = New-CimSessionOption -Protocol Wsman
        $session = New-CimSession -SessionOption $option `
                                  -ComputerName $Computer
        If ($PSBoundParameters.ContainsKey('NewUser')) {
            $args = @{'StartName'=$NewUser
                      'StartPassword'=$NewPassword}
        } Else {
            $args = @{'StartPassword'=$NewPassword}
        }
        $params = @{'CimSession'=$session
                    'MethodName'='Change'
                    'Query'="SELECT * FROM Win32_Service
                          ➥ WHERE Name = '$ServiceName'"
                    'Arguments'=$args}
        $ret = Invoke-CimMethod @params
        switch ($ret.ReturnValue) {
            0  { $status = "Success" }
            22 { $status = "Invalid Account" }
            Default { $status = "Failed: $($ret.ReturnValue)" }
        }
        $props = @{'ComputerName'=$computer
                   'Status'=$status}
        $obj = New-Object -TypeName PSObject -Property $props
        Write-Output $obj
        $session | Remove-CimSession
    } #foreach
} #PROCESS
END{}
} #function
```

Hopefully you noticed a few things:

- We changed to using the CIM session instead of a computer name. Bet you were wondering about that, right? Well, we hope you were. Why'd we do it? Just to see if you were paying attention.
- We've switched to splatting.
- Notice our use of the `switch` construct to construct the status message. You can also see that we used the + symbol when defining the query. The only reason we did this was to format the code to fit properly on the

page. Normally, you’d write out the query as a single line: `"SELECT * FROM Win32_Service WHERE Name = '$ServiceName'"`, and that’s what you’ll see in the code download.

Accumulating results will make your command block the pipeline; outputting objects one at a time allows the pipeline to run multiple commands in parallel

13 Using all the Streams

You may need to flip back a few chapters and refamiliarize yourself with the `[CmdletBinding()]` keyword. We can add this to a `Param()` block, which turns our function into an advanced function that enables the commands for verbose, warning, informational, and other output. Well, it's time to put that to use and demonstrate why you'd want to use them.

13.1 Knowing the 7 output streams

It's useful to understand that PowerShell has six *output streams*, rather than the one we normally think of. First up and the one you are most familiar with is the *Success* stream, which is the one you're used to thinking of as "the end of the pipeline." This gets some special treatment from the PowerShell engine. For example, it's the pipeline used to pass objects from command to command. Additionally, at the end of the pipeline, PowerShell sort of invisibly adds the `Out-Default` cmdlet, which runs any objects in the pipeline through PowerShell's formatting system. Whatever hosting application you're using—the PowerShell console, VSCode, and so on—is responsible for dealing with that output by placing it onto the screen or doing something else with it.

There are 7 streams in all

1. Success, which we discussed above
2. Error
3. Warning
4. Verbose
5. Debug
6. Information
7. Progress

Those numbers correspond with how PowerShell references each pipeline for redirection purposes.

Each pipeline represents a discrete, independent way of passing information. Each hosting application decides how to deal with each pipeline. For example, the console host displays items from pipeline 4 (Verbose) in yellow text, prefixed by “VERBOSE:”. Other hosts might log that output to an event log or ignore it.

Additionally, the shell defines several *preference* variables that control each pipeline’s output. `$VerbosePreference` controls pipeline 4, `$WarningPreference` controls 3, and so on. Setting a preference to SilentlyContinue will suppress that pipeline’s output; setting it to Continue will display the output in whatever way the host application defines. The common parameters override the preference variables on a per-command basis. For example, adding `-Verbose` to your command when you run it, will enable `Write-Verbose` output in the command.

13.2 Adding verbose and warning output

Verbose output is disabled by default, but warning output is enabled. With that in mind, we do something like the following with those two forms of output.

Listing 13.1 Adding output

```
function Get-MachineInfo {
    [CmdletBinding()]
    Param(
        [Parameter(ValueFromPipeline=$True,
                   Mandatory=$True)]
        [Alias('CN','MachineName','Name')]
        [string[]]$ComputerName,
        [string]$LogFailuresToPath,
        [ValidateSet('Wsman','Dcom')]
        [string]$Protocol = "Wsman",
        [switch]$ProtocolFallback
    )
 BEGIN {}
 PROCESS {
    foreach ($computer in $computername) {
        if ($protocol -eq 'Dcom') {
            $option = New-CimSessionOption -Protocol Dcom
        } else {
```

```
            $option = New-CimSessionOption -Protocol Wsman
        }
        Write-Verbose "Connecting to $computer over $protocol"
        $session = New-CimSession -ComputerName $computer `
                                  -SessionOption $option
        Write-Verbose "Querying from $computer"
        $os_params = @{'ClassName'='Win32_OperatingSystem'
                       'CimSession'=$session}
        $os = Get-CimInstance @os_params
        $cs_params = @{'ClassName'='Win32_ComputerSystem'
                       'CimSession'=$session}
        $cs = Get-CimInstance @cs_params
        $sysdrive = $os.SystemDrive
        $drive_params = @{'ClassName'='Win32_LogicalDisk'
                          'Filter'="DeviceId='$sysdrive'"
                          'CimSession'=$session}
        $drive = Get-CimInstance @drive_params
        $proc_params = @{'ClassName'='Win32_Processor'
                         'CimSession'=$session}
        $proc = Get-CimInstance @proc_params |
                Select-Object -first 1
        Write-Verbose "Closing session to $computer"
        $session | Remove-CimSession
        Write-Verbose "Outputting for $computer"
        $obj = [pscustomobject]@{'ComputerName'=$computer       #
                   'OSVersion'=$os.version
                   'SPVersion'=$os.servicepackmajorversion
                   'OSBuild'=$os.buildnumber
                   'Manufacturer'=$cs.manufacturer
                   'Model'=$cs.model
                   'Procs'=$cs.numberofprocessors
                   'Cores'=$cs.numberoflogicalprocessors
                   'RAM'=($cs.totalphysicalmemory / 1GB)
                   'Arch'=$proc.addresswidth
                   'SysDriveFreeSpace'=$drive.freespace}
        Write-Output $obj
    } #foreach
} #PROCESS
END {}
} #function
```

Sharp-eyed readers will notice two things:

- We sneaked in a change to the `New-Object` creation. This is mainly to show you a new technique that you may run across. Rather than defining a hash table of properties and passing it to `New-Object`, we use the

`[pscustomobject]` type accelerator to do the same job in a bit less space. We touched on this type of accelerator in the previous chapter.
- We've replaced a lot of our inline comments with verbose output. This lets the same message be seen by someone *running* the code, provided they add `-Verbose` when doing so. If the command is run without `-Verbose`, the `Write-Verbose` lines will still be run, but you won't see the output.

You haven't added any warning output yet, because you haven't needed it. But you will, eventually—so keep `Write-Warning` in the back of your brain. Eventually, you'll add statements like this:

```
write-warning "Danger, Danger!"
```

13.3 Doing more with -Verbose

If you take a moment to think about it, you'll realize that incorporating `Write-Verbose` statements into your tools makes a lot of sense. In fact, we recommend that you include the statements from the beginning. Don't wait to add them until after you've finished scripting. Add them first! Insert verbose messages throughout your script that highlight what action your command is performing, or the values of key variables. This will help you troubleshoot and debug during the development process, because you can run your command with `-Verbose`. The verbose messages can also double as internal documentation. Finally, if someone is trying to run your tool and is encountering problems, you can have them start a transcript, run the command with `-Verbose`, and then close the transcript and send it to you. If you've written good verbose messages, you'll be able to track what's happening and, hopefully, identify the problem.

Consider adding verbose messages like this at the beginning of your command:

```
Write-Verbose "Execution Metadata:"
Write-Verbose "User = $($env:userdomain)\$($env:USERNAME)"
$id = [System.Security.Principal.WindowsIdentity]::GetCurrent()
$IsAdmin = [System.Security.Principal.WindowsPrincipal]::new($id)
 'administrators')
Write-Verbose "Is Admin = $IsAdmin"
```

```
Write-Verbose "Computername = $env:COMPUTERNAME"
Write-Verbose "OS = $((Get-CimInstance Win32_Operatingsystem).Cap
Write-Verbose "Host = $($host.Name)"
Write-Verbose "PSVersion = $($PSVersionTable.PSVersion)"
Write-Verbose "Runtime = $(Get-Date)"
```

When this is executed, you'll get potentially useful information:

```
VERBOSE: Execution Metadata:
VERBOSE: User = Win10Laptop\James
VERBOSE: Is Admin = False
VERBOSE: Computername = Win10Laptop
VERBOSE: Perform operation 'Enumerate CimInstances' with followin
parameters, ''namespaceName' = root\cimv2,'className' =
Win32_Operatingsystem'.
VERBOSE: Operation 'Enumerate CimInstances' complete.
VERBOSE: OS = Microsoft Windows 10.0 Professional
VERBOSE: Host = Microsoft Studio Code Host
VERBOSE: PSVersion = 7.3.2
VERBOSE: Runtime = 02/01/2023 13:57:25
```

Keep in mind that you have no control over other commands that support verbose output, like the `Get-CimInstance` cmdlet does in our example, so your verbose output may not always be perfect.

Another tip is to add a prefix to each verbose message that indicates what script block is being called:

```
Function TryMe {
[cmdletbinding()]
Param(
[string]$Computername
)
Begin {
    Write-Verbose "[BEGIN  ] Starting: $($MyInvocation.Mycommand)
    Write-Verbose "[BEGIN  ] Initializing array"
    $a = @()
} #begin
Process {
    Write-Verbose "[PROCESS] Processing $Computername"
    # code goes here
} #process
End {
    Write-Verbose "[END    ] Ending: $($MyInvocation.Mycommand)"
} #end
```

```
} #function
```

See how there's sort of a block-comment effect? This makes it easier to know exactly where your command is. Note the use of padded spaces. We did this to make the verbose output easier to read in the console:

```
PS C:\> tryme -Computername FOO -Verbose
VERBOSE: [BEGIN  ] Starting: TryMe
VERBOSE: [BEGIN  ] Initializing array
VERBOSE: [PROCESS] Processing FOO
VERBOSE: [END    ] Ending: TryMe
```

Consider including a timestamp. This is especially useful for long-running commands:

```
Function TryMe {
[cmdletbinding()]
Param(
[string]$Computername
)
Begin {
    Write-Verbose "[$((get-date).TimeOfDay.ToString()) BEGIN  ] S
     $($MyInvocation.Mycommand)"
    Write-Verbose "[$((get-date).TimeOfDay.ToString()) BEGIN  ] `
    Initializing array"
    $a = @()
} #begin
Process {
    Write-Verbose "[$((get-date).TimeOfDay.ToString()) PROCESS] P
 $Computername"
    # code goes here
} #process
End {
    Write-Verbose "[$((get-date).TimeOfDay.ToString()) END    ] E
 $($MyInvocation.Mycommand)"
} #end
} #function
```

You'll get verbose output like this:

```
VERBOSE: [15:18:55.3840626 BEGIN  ] Starting: TryMe
VERBOSE: [15:18:55.4040871 BEGIN  ] Initializing array
VERBOSE: [15:18:55.4080634 PROCESS] Processing FOO
VERBOSE: [15:18:55.4090586 END    ] Ending: TryMe
```

There's no limit to how you can use verbose messages. It's up to you to decide what information would be helpful to. With that in mind, our last tip is to include a verbose message that indicates the name of your command. That's what the line `$myinvocation .mycommand` provided. The built-in variable `$MyInvocation` can provide usefuhelpfulrmation; the `MyCommand` property indicates the name of your command. This is especially helpful if your command is calling other commands. Including the type of verbose information we've suggested makes it much easier to trace the flow of your PowerShell expression.

13.4 Information output

Sixth channel was introduced in PowerShell v5, which more or less did away with its original `Write-Host` cmdlet and turned `Write-Host` into a wrapper around `Write-Information`. The Information stream is a bit different from other pipelines that can carry messages, because it's designed to carry *structured* messages. It requires a bit of preplanning to use well. But there's still an `$InformationPreference` variable that can suppress or allow the output of this stream, and it's set to SilentlyContinue, or Off, by default. When you run a command, you can specify `-InformationAction Continue` to enable that command's informational output.

`$InformationPreference` and `-InformationAction` are automatically set to Continue when you use `Write-Host` so that `Write-Host` behaves as it did in previous versions of PowerShell.

On a basic level, using `Write-Information` isn't any different than using `Write-Verbose`. The `-MessageData` parameter is in the first position, so you can often skip using the parameter name and add whatever message you want to include—the same as we just did with `Write-Verbose`. But messages can also be *tagged*, usually with a keyword like *information*, *instructions*, or whatever you decide. The information stream can then be *searched* based on those tags. You can also run commands using the `-InformationVariable` parameter to have informational messages added to a variable that you designate. This can help keep the information messages from cluttering up your normal output.

Here's an example:

```
Function Example {
    [CmdletBinding()]
    Param()
    Write-Information "First message" -tag status
    Write-Information "Note that this had no parameters" -tag not
    Write-Information "Second message" -tag status
}
Example -InformationAction Continue -InformationVariable x
```

Using Continue this way makes it apply to all `Write-Information` commands *inside* the `Example` function. And if you run this (in PowerShell v5 or later), you'll see that the informational messages do indeed appear. Were you to examine `$x`, you'd find the messages in it, as well. Contrast the previous example with this:

```
function Example {
    [CmdletBinding()]
    Param()
    Write-Information "First message" -tag status
    Write-Information "Note that this had no parameters" -tag not
    Write-Information "Second message" -tag status
}
Example -InformationAction SilentlyContinue -IV x
```

This time, the messages don't appear, because we used SilentlyContinue. But *the commands still run and work, and if you were to examine $x, you'd find all three messages*. Notice that we shortened `-InformationVariable` to its `-IV` alias to save some room.

Let's now go one step further:

```
function Example {
    [CmdletBinding()]
    Param()
    Write-Information "First message" -tag status
    Write-Information "Note that this had no parameters" -tag not
    Write-Information "Second message" -tag status
}
Example -InformationAction SilentlyContinue -IV x
$x | where tags -in @('notice')
```

In this example, only the second message, “Note that this had no parameters”, will display, because we filtered that out of `$x` by using the `Tags` property of the messages.

13.4.1 A detailed information example

Like verbose output, effectively using the Information channel requires some planning. You have to figure out what needs to be logged and how it might be used, and you need to implement your `Write-Information` commands when creating your tool. Here’s a simple function to illustrate how you might use `Write-Information`. You can find a file with these test functions in the code folder for this chapter at https://www.manning.com/books/learn-powershell-scripting-in-a-month-of-lunches

Listing 13.2 Using an information variable

```
Function Test-Me {
[cmdletbinding()]
Param()
Write-Information "Starting $($MyInvocation.MyCommand) " -Tags Pr
Write-Information "PSVersion = $($PSVersionTable.PSVersion)" -Tag
Write-Information "OS = $((Get-CimInstance Win32_operatingsystem)
-Tags Meta
Write-Verbose "Getting top 5 processes by WorkingSet"
Get-process | sort WS -Descending | select -first 5 -OutVariable
Write-Information ($s[0] | Out-String) -Tags Data
Write-Information "Ending $($MyInvocation.MyCommand) " -Tags Proc
}
```

Running the command normally will give you the top five processes by working set. Now, run it like this:

```
PS C:\> test-me -InformationAction Continue
Starting Test-Me
PSVersion =  7.3.2
OS = Microsoft Windows 10 Pro Insider Preview
Handles  NPM(K)    PM(K)      WS(K) VM(M)   CPU(s)     Id  SI Pro
-------  ------    -----      ----- -----   ------     --  -- ---
   2145     249   856976     883488  1931 7,151.38   5948   1 fir
   2692     126   769444     396928 ...86 1,531.13   8552   1 pow
    373      59   310584     390504  1421   446.03   7172   1 sla
    395      55   186628     361964  1391   590.89   7508   1 sla
```

```
   1181      95   335932     317060  1216   375.38   1004   1 pow
Handles  NPM(K)    PM(K)      WS(K) VM(M)   CPU(s)     Id  SI Pro
-------  ------    -----      ----- -----   ------     --  -- ---
   2145     249   856976     883488  1931 7,151.38   5948   1 fir
Ending Test-Me
```

By setting the common parameter `-InformationAction` to Continue, you turn on the Information channel, which also displays the information. This can be useful when you're building messages and want to see what they will do.

Next, run the command using the `-InformationVariable` parameter:

```
PS C:\> test-me -InformationVariable inf
```

You won't get the information messages, because the command is running with the default SilentlyContinue setting for information messages, suppressing them. Instead, they're directed to the variable `inf`:

```
PS C:\> $inf
Starting Test-Me
PSVersion =  7.3.2
OS = Microsoft Windows 10 Pro
Handles  NPM(K)    PM(K)      WS(K) VM(M)   CPU(s)     Id  SI Pro
-------  ------    -----      ----- -----   ------     --  -- ---
   2142     248   857768     883332  1904 7,155.00   5948   1 fir
Ending Test-Me
```

You get back a very rich object:

```
PS C:\> $inf | get-member
   TypeName: System.Management.Automation.InformationRecord
Name             MemberType Definition
----             ---------- ----------
Equals           Method     bool Equals(System.Object obj)
GetHashCode      Method     int GetHashCode()
GetType          Method     type GetType()
ToString         Method     string ToString()
Computer         Property   string Computer {get;set;}
ManagedThreadId  Property   uint32 ManagedThreadId {get;set;}
MessageData      Property   System.Object MessageData {get;}
NativeThreadId   Property   uint32 NativeThreadId {get;set;}
ProcessId        Property   uint32 ProcessId {get;set;}
Source           Property   string Source {get;set;}
```

```
Tags            Property   System.Collections.Generic.List[string
TimeGenerated   Property   datetime TimeGenerated {get;set;}
User            Property   string User {get;set;}
```

This means you can work with the data however you'd like:

```
PS C:\> $inf.where({$_.tags -contains 'meta'}) |
select Computer,Messagedata
Computer   MessageData
--------   -----------
Win10-01   PSVersion =  7.3.2
Win10-01   OS = Microsoft Windows 10 Pro Insider Preview
```

The key takeaway is that the information parameters are irrelevant if your command doesn't have any Write-Information commands.

But as we mentioned earlier, in PowerShell v5, `Write-Host` was refactored as a conduit for `Write-Information`. Check this revised version of the function.

Listing 13.3 Revised function

```
Function Test-Me2 {
[cmdletbinding()]
Param()
Write-Host "Starting $($MyInvocation.MyCommand) " -foreground gre
Write-Host "PSVersion = $($PSVersionTable.PSVersion)" -foreground
Write-Host "OS = $((Get-CimInstance Win32_operatingsystem).Captio
 -foreground green
Write-Verbose "Getting top 5 processes by WorkingSet"
Get-Process | sort WS -Descending | select -first 5 -OutVariable
Write-Host ($s[0] | Out-String) -foreground green
Write-Host "Ending $($MyInvocation.MyCommand) " -foreground green
}
```

One benefit of using `Write-Host` is the ability to colorize the output. Unfortunately, even if you run the command like this

```
test-me2 -InformationVariable inf2
```

the information output will be saved to `$inf2`. But the informational messages will also be written to the host in green. This may not be desirable. This technique also loses the ability to add tags.

Here’s one final version that’s more a proof of concept than anything. You really need to run it for yourself to see the results.

Listing 13.4 Proof of concept

```
Function Test-Me3 {
[cmdletbinding()]
Param()
if ($PSBoundParameters.ContainsKey("InformationVariable")) {
 $Info = $True
 $infVar = $PSBoundParameters["InformationVariable"]
}
if ($info) {
 Write-Host "Starting $($MyInvocation.MyCommand) " -foreground gr
 (Get-Variable $infVar).value[-1].Tags.Add("Process")
 Write-Host "PSVersion = $($PSVersionTable.PSVersion)" -foregroun
 (Get-Variable $infVar).value[-1].Tags.Add("Meta")
 Write-Host "OS = $((Get-CimInstance Win32_operatingsystem).Capti
 -foreground green
 (Get-Variable $infVar).value[-1].Tags.Add("Meta")
}
Write-Verbose "Getting top 5 processes by WorkingSet"
Get-process | sort WS -Descending | select -first 5 -OutVariable
if ($info) {
 Write-Host ($s[0] | Out-String) -foreground green
 (Get-Variable $infVar).value[-1].Tags.Add("Data")
 Write-Host "Ending $($MyInvocation.MyCommand) " -foreground gree
 (Get-Variable $infVar).value[-1].Tags.Add("Process")
}
}
```

This function tests to see whether `–InformationVariable` was specified; if so, a variable (`$Info`) is switch on. When information is needed via `Write-Host`, if `$Info` is True, then the `Write-Host` lines are called. Immediately after each line, a tag is added to the information variable:

```
test-me3 -InformationVariable inf3
```

This displays the information messages in green and generates the information variable:

```
PS C:\> $inf3 | Group {$_.tags -join "-"}
Count Name                      Group
----- ----                      -----
```

```
    2 PSHOST-Process              {Starting Test-Me3 , Ending Test-
    2 PSHOST-Meta                 {PSVersion =  7.3.2, OS = Mi...}
    1 PSHOST-Data                 {...
```

Before we move on, don’t forget that information variables are just another type of object. You could export the variable using `Export-Clixml`, store the results in a database, or create a custom text log file from the different properties.

Verbose output is still a good choice when you’re using PowerShell versions prior to 5. Once you’re using 5, it may make sense to start migrating to information messages instead, given their flexibility, tags, and searchability. For now, because we’re aiming for greater compatibility, we’re sticking with verbose output in our examples.

13.5 Your turn

As you might imagine, you’re going to add some verbose output to your tool.

13.5.1 Start here

Here’s where we left off after the previous chapter. You can start here (or use our code sample from the download), or begin with your result from the previous chapter.

Listing 13.5 Set-TMServiceLogon

```
function Set-TMServiceLogon {
    [CmdletBinding()]
    Param(
        [Parameter(Mandatory=$True,
                   ValueFromPipelineByPropertyName=$True)]
        [string]$ServiceName,
        [Parameter(Mandatory=$True,
                   ValueFromPipeline=$True,
                   ValueFromPipelineByPropertyName=$True)]
        [string[]]$ComputerName,
        [Parameter(ValueFromPipelineByPropertyName=$True)]
        [string]$NewPassword,
        [Parameter(ValueFromPipelineByPropertyName=$True)]
```

```
        [string]$NewUser,
        [string]$ErrorLogFilePath
    )
BEGIN{}
PROCESS{
    ForEach ($computer in $ComputerName) {
        $option = New-CimSessionOption -Protocol Wsman
        $session = New-CimSession -SessionOption $option `
                                  -ComputerName $Computer
        If ($PSBoundParameters.ContainsKey('NewUser')) {
            $args = @{'StartName'=$NewUser
                      'StartPassword'=$NewPassword}
        } Else {
            $args = @{'StartPassword'=$NewPassword}
        }
        $params = @{'CimSession'=$session
                    'MethodName'='Change'
                    'Query'="SELECT * FROM Win32_Service " +
                            "WHERE Name = '$ServiceName'"
                    'Arguments'=$args}
        $ret = Invoke-CimMethod @params
        switch ($ret.ReturnValue) {
            0  { $status = "Success" }
            22 { $status = "Invalid Account" }
            Default { $status = "Failed: $($ret.ReturnValue)" }
        }
        $props = @{'ComputerName'=$computer
                   'Status'=$status}
        $obj = New-Object -TypeName PSObject -Property $props
        Write-Output $obj
        $session | Remove-CimSession
    } #foreach
} #PROCESS
END{}
} #function
```

13.5.2 Your task

Add some meaningful verbose output to your tool. If you see an opportunity to add warning output, feel free to add that as well.

13.5.3 Our take

Here’s what we came up with.

Listing 13.6 Our solution

```
function Set-TMServiceLogon {
    [CmdletBinding()]
    Param(
        [Parameter(Mandatory=$True,
                   ValueFromPipelineByPropertyName=$True)]
        [string]$ServiceName,
        [Parameter(Mandatory=$True,
                   ValueFromPipeline=$True,
                   ValueFromPipelineByPropertyName=$True)]
        [string[]]$ComputerName,
        [Parameter(ValueFromPipelineByPropertyName=$True)]
        [string]$NewPassword,
        [Parameter(ValueFromPipelineByPropertyName=$True)]
        [string]$NewUser,
        [string]$ErrorLogFilePath
    )
BEGIN{}
PROCESS{
    ForEach ($computer in $ComputerName) {
        Write-Verbose "Connect to $computer on WS-MAN"
        $option = New-CimSessionOption -Protocol Wsman
        $session = New-CimSession -SessionOption $option `
                                  -ComputerName $Computer
        If ($PSBoundParameters.ContainsKey('NewUser')) {
            $args = @{'StartName'=$NewUser
                      'StartPassword'=$NewPassword}
        } Else {
            $args = @{'StartPassword'=$NewPassword}
            Write-Warning "Not setting a new user name"
        }
        Write-Verbose "Setting $servicename on $computer"
        $params = @{'CimSession'=$session
                    'MethodName'='Change'
                    'Query'="SELECT * FROM Win32_Service " +
                            "WHERE Name = '$ServiceName'"
                    'Arguments'=$args}
        $ret = Invoke-CimMethod @params
        switch ($ret.ReturnValue) {
            0  { $status = "Success" }
            22 { $status = "Invalid Account" }
            Default { $status = "Failed: $($ret.ReturnValue)" }
        }
        $props = @{'ComputerName'=$computer
                   'Status'=$status}
        $obj = New-Object -TypeName PSObject -Property $props
```

```
        Write-Output $obj
        Write-Verbose "Closing connection to $computer"
        $session | Remove-CimSession
    } #foreach
} #PROCESS
END{}
} #function
```

Add as much verbose output as you need to provide meaningful feedback or information. It costs you nothing to add the `Write-Verbose` commands, and they won’t be activated until you run the command with `-Verbose`.

14 Simple help: making a comment

One of the things we all love about PowerShell is its help system. Like Linux's `man` pages, PowerShell's help files can provide information, examples, instructions, and more. So we want to provide help with the tools we create—and you should, too. You have two ways of doing so. First is the easiest solution, which is comment-based help.

Simply put, you put the help files at the top of your scripts and functions, and PowerShell will interpret these as the help files. Alternatively, an external help file is generally written in MarkDown format. You can use modules such as PlatyPS to help create these files. For now, we will use the simpler, single-language, comment-based help inside your function.

14.1 Where do you put your help

There are three defined places where PowerShell will look for your specially formatted comments to turn them in to help displays:

- Just before your function's opening `function` keyword, with no blank lines between the last comment line and the function. We don't like this spot, because we prefer…
- Just inside the function, after the opening `function` declaration, and before your `[CmdletBinding()]` or `Param` parts. We love this spot because it's easier to move your help with the function if you're copying and pasting your code someplace else. Your comments will also collapse into the function if you use an editor with code-folding features. This is where you'll find that most people stick to their help.
- As the last thing in your function before the closing `}`. We're not fans of this spot, either, because having your comments at the top of the function helps better document the function for someone reading the code.

14.2 Getting started

As you'll see, there's nothing incredibly complicated about any of this. The best way to understand is to dive in and look at an example.

Listing 14.1 Comment-based help

```
function Get-MachineInfo {
<#
.SYNOPSIS
Retrieves specific information about one or more computers using
CIM.
.DESCRIPTION
This command uses either WMI or CIM to retrieve specific informat
one or more computers. You must run this command as a user with
permission to query CIM or WMI on the machines involved remotely.
specify a starting protocol (CIM by default), and specify that, i
event of a failure, the other protocol be used on a per-machine b
.PARAMETER ComputerName
One or more computer names. When using WMI, this can also be IP a
IP addresses may not work for CIM.
.PARAMETER LogFailuresToPath
A path and filename to write failed computer names to. If omitted
will be written.
.PARAMETER Protocol
Valid values: Wsman (uses CIM) or Dcom (uses WMI). It will be use
machines. "Wsman" is the default.
.PARAMETER ProtocolFallback
Specify this to try the other protocol if a machine fails automat
.EXAMPLE
Get-MachineInfo -ComputerName ONE,TWO,THREE
This example will query three machines.
.EXAMPLE
Get-ADUser -filter * | Select -Expand Name | Get-MachineInfo
This example will attempt to query all machines in AD.
#>
    [CmdletBinding()]
    Param(
        [Parameter(ValueFromPipeline=$True,
                   Mandatory=$True)]
        [Alias('CN','MachineName','Name')]
        [string[]]$ComputerName,
        [string]$LogFailuresToPath,
        [ValidateSet('Wsman','Dcom')]
        [string]$Protocol = "Wsman",
        [switch]$ProtocolFallback
    )
 BEGIN {}
```

```
 PROCESS {
    foreach ($computer in $computername) {
        if ($protocol -eq 'Dcom') {
            $option = New-CimSessionOption -Protocol Dcom
        } else {
            $option = New-CimSessionOption -Protocol Wsman
        }
        Write-Verbose "Connecting to $computer over $protocol"
        $session = New-CimSession -ComputerName $computer `
                                  -SessionOption $option
        Write-Verbose "Querying from $computer"
        $os_params = @{'ClassName'='Win32_OperatingSystem'
                       'CimSession'=$session}
        $os = Get-CimInstance @os_params
        $cs_params = @{'ClassName'='Win32_ComputerSystem'
                       'CimSession'=$session}
        $cs = Get-CimInstance @cs_params
        $sysdrive = $os.SystemDrive
        $drive_params = @{'ClassName'='Win32_LogicalDisk'
                          'Filter'="DeviceId='$sysdrive'"
                          'CimSession'=$session}
        $drive = Get-CimInstance @drive_params
        $proc_params = @{'ClassName'='Win32_Processor'
                         'CimSession'=$session}
        $proc = Get-CimInstance @proc_params |
                Select-Object -first 1
        Write-Verbose "Closing session to $computer"
        $session | Remove-CimSession
        Write-Verbose "Outputting for $computer"
        $obj = [pscustomobject]@{'ComputerName'=$computer
                   'OSVersion'=$os.version
                   'SPVersion'=$os.servicepackmajorversion
                   'OSBuild'=$os.buildnumber
                   'Manufacturer'=$cs.manufacturer
                   'Model'=$cs.model
                   'Procs'=$cs.numberofprocessors
                   'Cores'=$cs.numberoflogicalprocessors
                   'RAM'=($cs.totalphysicalmemory / 1GB)
                   'Arch'=$proc.addresswidth
                   'SysDriveFreeSpace'=$drive.freespace}
        Write-Output $obj
    } #foreach
} #PROCESS
END {}
} #function
```

The help here reflects what we believe is the bare minimum for inclusion in

the race of Upright Human Beings. Some notes

- You don't have to use all-uppercase letters, but the period preceding each help keyword (`.SYNOPSIS`, `.DESCRIPTION`) must be in the first column.
- We used a block comment (`<#....#>`); you could also use line-by-line words— each line preceded by a `#` character. The block comment looks nicer and is considered a collapsible region in some scripting editors.
- `.SYNOPSIS` is meant to describe what your command does concisely.
- `.DESCRIPTION` is a longer description full of details, instructions, and insights.
- `.PARAMETER` *is followed by the parameter name* and then a description of the parameters use. You don't need to provide a listing for every single parameter.
- `.EXAMPLE` should be followed immediately *by the example itself*; PowerShell will add a PowerShell prompt in front of this line when the help is displayed. If your tool takes advantage of different providers, such as the registry, you can certainly insert an appropriate prompt to illustrate your example. The subsequent text can explain the example.
- You can put blank comment lines between these settings to make it all easier to read in code.
- You normally don't need to worry about line length. PowerShell will wrap lines as necessary, depending on the console size of the current host. But if you want to manually break lines, a width of 80 characters is your best bet:

```
<#
.SYNOPSIS
Retrieves specific information about one or more computers using
CIM.
.DESCRIPTION
This command uses either WMI or CIM to retrieve specific informat
one or more computers. You must run this command as a user who ha
permission
to remotely query CIM or WMI on the machines involved. You can
specify a starting protocol (CIM by default) and specify that, in
event of a failure, the other protocol be used on a per-machine b
.PARAMETER ComputerName
One or more computer names. When using WMI, this can also be IP a
IP addresses may not work for CIM.
.PARAMETER LogFailuresToPath
```

```
A path and filename to write failed computer names to. If omitted
will be written.
.PARAMETER Protocol
Valid values: Wsman (uses CIM) or Dcom (uses WMI). It will be use
machines. "Wsman" is the default.
.PARAMETER ProtocolFallback
Specify this to automatically try the other protocol if a machine
.EXAMPLE
Get-MachineInfo -ComputerName ONE,TWO,THREE
This example will query three machines.
.EXAMPLE
Get-ADUser -filter * | Select -Expand Name | Get-MachineInfo
This example will attempt to query all machines in AD.
#>
```

As we wrote, these elements are the *bare minimum*. You can do more. A lot more.

14.3 Going further with comment-based help

You can use an `.INPUTS` section to list .NET class types, one per line, that your command accepts as input from the pipeline. This is useful for helping others understand what kinds of input your command can deal with:

```
.INPUTS
System.String
```

Similarly, `.OUTPUTS` lists the type names that your script outputs. Because ours presently only outputs a generic `PSObject`, there's not much point in listing anything.

A `.NOTES` section can list additional information, which is only displayed when the full help is requested by the user:

```
.NOTES
version     : 1.0.0
last updated: 1 February, 2023
```

A `.LINK` heading, followed by a topic name or a URL, appears as a Related Topic in the help. Use one `.LINK` keyword for each related topic; don't put multiples under a single `.LINK`:

```
.LINK
https://powershell.org/forums/
.LINK
Get-CimInstance
.LINK
Get-WmiObject
```

There's more, too—read the `about_comment_based_help` topic in PowerShell for the complete list. We'll include a few in upcoming chapters as we add functionality to those help keywords, so be on the lookout.

14.4 Broken help

PowerShell is very particular about help formatting and syntax. Get just one thing wrong, and none of the help will work, *and* you won't get an error message or explanation. So if you're not getting the help display you expect, carefully review your help keyword spelling, period locations, and other details.

14.5 Beyond comments

Comment-based help has more than a few limitations, but it's essential to understand why it exists. Initially, PowerShell only supported external help, stored in XML-based files written in a dialect called Microsoft Assistance Markup Language. MAML is incomprehensible—like, seriously unreadable to a human. But it offers advantages over comment-based help. Although it's harder to create, it

- It is separated from your code so that it can be updated independently. It's the basis of how PowerShell's `Update-Help` command works.
- It can be delivered in multiple languages, allowing PowerShell to offer localized help content to different audiences.
- It is parsed by PowerShell into an object hierarchy, providing additional features and functionality that can make help valuable content across a broader range of situations.

So if MAML is so cool but so hard to make, what do you do? Back then, many different folks made tools that let you copy and paste the content into a

GUI that would then spit out MAML files for you. Easier but super time-consuming. Nowadays, all the cool kids are using an open-source project called PlatyPS. PlatyPS lets you write your help content in Markdown, a simple markup language. Markdown is the native markup language of GitHub, meaning your help files can be easily read and edited on that website if you're hosting a project there. PlatyPS can then take that Markdown and produce a valid MAML file. Other tools can consume Markdown and produce HTML if you want to have web-based help for some reason. Markdown becomes the source format for your help (it's easy to read and edit with any text editor—you don't even need a dedicated Markdown editor, although VS Code has excellent Markdown plugins you can try), and you produce everything else from there.

If you've never written help for your code, PlatyPS can examine the code and create a framework, or *stub*, for your Markdown help files. The stub will include all of your parameters and so forth, with as much data as PlatyPS can figure out already filled in—like which parameters are mandatory, which ones accept pipeline input, and so on. PlatyPS can help you *maintain* your help files, too. Say you add a parameter, or change one, or whatever. It can look at your code, figure that out, and update your existing help files with stubs, which you can then fill in to document whatever's new and changed in your code fully.

We *love* PlatyPS and Markdown. Although they're more extensive topics than we were ready to tackle for this book, we wanted to give you some directions for future exploration.

14.6 Your turn

Time to add some comment-based help to your function.

14.6.1 Start here

Here's where we left off after chapter 13. You can use this as a starting point or use your result from that chapter.

Listing 14.2 Set-TMServiceLogon

```
function Set-TMServiceLogon {
    [CmdletBinding()]
    Param(
        [Parameter(Mandatory=$True,
                   ValueFromPipelineByPropertyName=$True)]
        [string]$ServiceName,
        [Parameter(Mandatory=$True,
                   ValueFromPipeline=$True,
                   ValueFromPipelineByPropertyName=$True)]
        [string[]]$ComputerName,
        [Parameter(ValueFromPipelineByPropertyName=$True)]
        [string]$NewPassword,
        [Parameter(ValueFromPipelineByPropertyName=$True)]
        [string]$NewUser,
        [string]$ErrorLogFilePath
    )
BEGIN{}
PROCESS{
    ForEach ($computer in $ComputerName) {
        Write-Verbose "Connect to $computer on WS-MAN"
        $option = New-CimSessionOption -Protocol Wsman
        $session = New-CimSession -SessionOption $option `
                                  -ComputerName $Computer
        If ($PSBoundParameters.ContainsKey('NewUser')) {
            $args = @{'StartName'=$NewUser
                      'StartPassword'=$NewPassword}
        } Else {
            $args = @{'StartPassword'=$NewPassword}
            Write-Warning "Not setting a new user name"
        }
        Write-Verbose "Setting $servicename on $computer"
        $params = @{'CimSession'=$session
                    'MethodName'='Change'
                    'Query'="SELECT * FROM Win32_Service " +
                            "WHERE Name = '$ServiceName'"
                    'Arguments'=$args}
        $ret = Invoke-CimMethod @params
        switch ($ret.ReturnValue) {
            0  { $status = "Success" }
            22 { $status = "Invalid Account" }
            Default { $status = "Failed: $($ret.ReturnValue)" }
        }
        $props = @{'ComputerName'=$computer
                   'Status'=$status}
        $obj = New-Object -TypeName PSObject -Property $props
        Write-Output $obj
        Write-Verbose "Closing connection to $computer"
        $session | Remove-CimSession
```

```
    } #foreach
} #PROCESS
END{}
} #function
```

14.6.2 Your task

Add, at a minimum, the following to your tool:

- Synopsis
- Description
- Parameter descriptions
- Two examples, including descriptions

Import your module, and test your help (`Help Set-TMServiceLogon -ShowWindow`, for example) to make sure it works.

14.6.3 Our take

Here's the help we came up with. As always, you'll find this in the code downloads at www.manning.com/books/learn-powershell-scripting-in-a-month-of-lunches, under this chapter's folder.

Listing 14.3 Our solution

```
function Set-TMServiceLogon {
<#
.SYNOPSIS
Sets service login name and password.
.DESCRIPTION
This command uses either CIM (default) or WMI to
set the service password, and optionally the logon
user name, for a service, which can be running on
one or more remote machines. You must run this command
as a user who has permission to perform this task,
remotely, on the computers involved.
.PARAMETER ServiceName
The name of the service. Query the Win32_Service class
to verify that you know the correct name.
.PARAMETER ComputerName
One or more computer names. Using IP addresses will
fail with CIM; they will work with WMI. CIM is always
```

```
attempted first.
.PARAMETER NewPassword
A plain-text string of the new password.
.PARAMETER NewUser
Optional; the new logon user name, in DOMAIN\USER
format.
.PARAMETER ErrorLogFilePath
If provided, this is a path and filename of a text
file where failed computer names will be logged.
#>
    [CmdletBinding()]
    Param(
        [Parameter(Mandatory=$True,
                   ValueFromPipelineByPropertyName=$True)]
        [string]$ServiceName,
        [Parameter(Mandatory=$True,
                   ValueFromPipeline=$True,
                   ValueFromPipelineByPropertyName=$True)]
        [string[]]$ComputerName,
        [Parameter(ValueFromPipelineByPropertyName=$True)]
        [string]$NewPassword,
        [Parameter(ValueFromPipelineByPropertyName=$True)]
        [string]$NewUser,
        [string]$ErrorLogFilePath
    )
BEGIN{}
PROCESS{
    ForEach ($computer in $ComputerName) {
        Write-Verbose "Connect to $computer on WS-MAN"
        $option = New-CimSessionOption -Protocol Wsman
        $session = New-CimSession -SessionOption $option `
                                  -ComputerName $Computer
        If ($PSBoundParameters.ContainsKey('NewUser')) {
            $args = @{'StartName'=$NewUser
                      'StartPassword'=$NewPassword}
        } Else {
            $args = @{'StartPassword'=$NewPassword}
            Write-Warning "Not setting a new user name"
        }
        Write-Verbose "Setting $servicename on $computer"
        $params = @{'CimSession'=$session
                    'MethodName'='Change'
                    'Query'="SELECT * FROM Win32_Service " +
                            "WHERE Name = '$ServiceName'"
                    'Arguments'=$args}
        $ret = Invoke-CimMethod @params
        switch ($ret.ReturnValue) {
```

```
            0  { $status = "Success" }
            22 { $status = "Invalid Account" }
            Default { $status = "Failed: $($ret.ReturnValue)" }
        }
        $props = @{'ComputerName'=$computer
                   'Status'=$status}
        $obj = New-Object -TypeName PSObject -Property $props
        Write-Output $obj
        Write-Verbose "Closing connection to $computer"
        $session | Remove-CimSession
    } #foreach
} #PROCESS
END{}
} #function
```

Adding comment-based help doesn't have to be a tedious chore. Use the snippets feature of your scripting editor to create a template. In the PowerShell ISE, if you press Ctrl-J to access the built-in snippets, the one for Cmdlet (Advanced Function) will have most of what you need.

And before we sign off, here's a quick pro tip: Comment-based help tolerates extra whitespace. So instead of this

```
.SYNOPSIS
Sets service login name and password.
.DESCRIPTION
This command uses either CIM (default) or WMI to
set the service password, and optionally the logon
user name for a service which can be running on
one or more remote machines. You must run this command
as a user who has permission to perform this task,
remotely, on the computers involved.
.PARAMETER ServiceName
The name of the service. Query the Win32_Service class
to verify that you know the correct name.
```

You could do this:

```
.SYNOPSIS
Sets service login name and password.
.DESCRIPTION
This command uses either CIM (default) or WMI to
set the service password and, optionally, the logon
user name for a service, which can run on
one or more remote machines. You must run this command
```

```
as a user who has permission to perform this task
remotely on the computers involved.
.PARAMETER ServiceName
The name of the service. Query the Win32_Service class
to verify that you know the correct name.
```

Those extra blank lines go a *long* way toward making your code more readable, and they don't affect the help-file displays that PowerShell creates from your com

15 Errors and how to deal with them

You have much functionality yet to write in the tool you've been building, and we've been deferring a lot of it to this point. In this chapter, we'll focus on how to capture, deal with, log, and otherwise handle errors the tool may encounter.

Note

PowerShell.org offers a free eBook, *The Big Book of PowerShell Error Handling*, which dives into this topic from a more technical reference perspective (https://powershell.org/free-resources/). We recommend checking it out once you've completed this tutorial-focused chapter.

15.1 Understanding Errors and Exceptions

PowerShell defines two broad types of bad situations: errors and exceptions. Because most PowerShell commands are designed to deal with multiple things at once, and because a problem with one thing doesn't mean you want to stop dealing with all the other things, PowerShell tries to err on the side of "keep going until it breaks." So, PowerShell will often emit an error when something goes wrong in a command and keep going. For example

```
Get-Service -Name BITS, Nobody, WinRM
```

Figure 15.1 Error message for Nobody service

```
PS C:\tools> Get-Service -Name BITS, Nobody, WinRM
Get-Service: Cannot find any service with service name 'Nobody'.

Status   Name               DisplayName
------   ----               -----------
Stopped  BITS               Background Intelligent Transfer Servi…
Running  WinRM              Windows Remote Management (WS-Managem…
```

No service is called `Nobody` so PowerShell will emit an *error* on that second item (notice the red text in figure 15.1. But by default, PowerShell continues processing-cess the third item in the list. When PowerShell is in this keep-going mode, *you can't have your code respond to the problem condition*. If you want to do something about the problem, you must change PowerShell's default response to this -*terminating error*.

At a global level, PowerShell defines an `$ErrorActionPreference` variable, which tells PowerShell what to do in the event of a non-terminating error. This variable tells PowerShell what to do when a problem arises, but PowerShell can keep going. The default value for this variable is Continue. Here are the other options:

- *Continue*—Emits an error message and keeps going. Your code can't detect that a problem occurred, so you can't do anything else.
- *SilentlyContinue*—Doesn't emit an error message and keeps going. Again, you can't detect the problem or respond to it yourself.
- *Inquire*—Display a prompt, and ask the user whether to continue or stop.
- *Stop*—Turns the non-terminating *error* into a *terminating exception* and stops running the command. *This* is something your code can detect and respond to.
- *Ignore*—Not a value for this preference variable, but it can be used on the `-Error-Action` parameter, which we'll cover in a moment. Its behavior is similar to SilentlyContinue.
- *Suspend*—Only applies to errors in a PowerShell workflow, which is outside the scope of this book.

try it now

Run $`ErrorActionPreference` from a powershell prompt. You should be set to `Continue` unless it has been changed already

It is considered best practice to leave `$ErrorActionPreference` as-is. But instead, you'll typically want to specify a behavior on a per-command basis. You can do this using the `-ErrorActionPreference` common parameter or its alias (`-EA`, which we are using to save space in this book), which exists on every PowerShell command—even the ones you write yourself that include `[CmdletBinding()]`.

For example, try running these commands, and note the different behaviors:

```
Get-Service -Name BITS, Nobody, WinRM -EA Continue
Get-Service -Name BITS, Nobody, WinRM -EA SilentlyContinue
Get-Service -Name BITS, Nobody, WinRM -EA Inquire
Get-Service -Name BITS, Nobody, WinRM -EA Ignore
Get-Service -Name BITS, Nobody, WinRM -EA Stop
```

Remember that *you can't handle exceptions in your code* unless PowerShell *generates an exception*. Unless you run them with the Stop error action, most commands won't generate an exception. One of the biggest mistakes people make is forgetting to add `-EA Stop` to a command where they want to handle the problem.

15.2 Bad handling

We see people engage in two fundamentally bad practices. These aren't *always, always, always* bad, but they're *usually* bad, so we want to bring them to your attention.

First up is globally setting the preference variable right at the top of a script or function:

```
$ErrorActionPreference='SilentlyContinue'
```

In the olden days of VBScript, people used `On Error Resume Next`. This says, "I don't want to know if anything is wrong with my code." People do this misguidedlyuppress possible errors that they know won't matter. For example, attempting to delete a file that doesn't exist will cause an error—but

you probably don’t care because the mission is accomplished either way, right? But to suppress that unwanted error, you should use `-EA SilentlyContinue` on the `Remove-Item` command, not globally suppressing *all* errors in your script.

The other bad practice is slightly more subtle and can arise in the same situation. Suppose you *run Remove-Item with -EA SilentlyContinue, and then suppose you try to delete a file that does exist but doesn’t* have permission to delete. You’ll suppress the error and wonder why the file still exists.

Before you start suppressing errors, make sure you’ve thought it through. Nothing is more vexing than spending hours debugging a script because you suppressed an error message that would have told you where the problem was. We can’t tell you how often this comes up in forum questions.

15.3 Two reasons for exception handling

There are two broad reasons to handle exceptions in your code. (Notice that we’re using their official name, *exceptions*, to differentiate them from the non-handle-able *errors* we wrote about previously.)

Reason one is that you plan to run your tool out of your view. Perhaps it’s a scheduled task, or maybe you’re writing tools that remote customers will use. In either case, you want to make sure you have evidence for any problems that occur to help you with debugging. In this scenario, you might globally set `$ErrorActionPreference` to Stop at the top of your script and wrap the entire script in an error-handling construct. Any errors, even unanticipated ones, can be trapped and logged for diagnostic purposes. Although this scenario is valid, it isn’t the one we will focus on in this book.

We’ll focus on reason two: you’re running a command *where you can anticipate a certain kind of problem and* want to deal with that problem actively. This might be a failure to connect to a computer, a failure to log on to something, or another scenario. Let’s dig into that with the tool you’ve been building.

15.4 Handling exceptions in your tool

In the tool you've been building, you can anticipate the `New-CimSession` command running into problems: A computer might be offline or nonexistent, or the computer might not work with the selected protocol. You want to catch that condition and, depending on the parameters you ran with, log the failed computer name to a text file and/or try again using the other protocol. You'll start by focusing on the command that could cause the problem, and make sure it'll generate a *terminating exception* if it runs into trouble. Change this:

```
Write-Verbose "Connecting to $computer over $protocol"
$session = New-CimSession -ComputerName $computer `
                          -SessionOption $option
```

to this:

```
Write-Verbose "Connecting to $computer over $protocol"
$params = @{'ComputerName'=$Computer
            'SessionOption'=$option
            'ErrorAction'='Stop'}
$session = New-CimSession @params
```

It's important to notice that you've already constructed the command so that it only attempts to connect to one computer at a time utilizing the `ForEach` loop. Any time you'll be handling errors, it's crucial that you construct things so that only *one thing can fail at a time*. That's because you're telling PowerShell *not to continue*. If you attempted five computers at once, a failure in any of them would result in the rest of them never being attempted. Make sure you understand why this design principle is so important!

Just changing the error action to Stop isn't enough, though. You also need to wrap your code in a `Try/Catch` construct. If an exception occurs in the `Try` block, then all the subsequent code in the `Try` block will be skipped, and the `Catch` block will execute instead. So the `PROCESS{}` block of the function now looks like this:

```
 PROCESS {
    For each ($computer in $computername) {
        if ($protocol -eq 'Dcom') {
            $option = New-CimSessionOption -Protocol Dcom
        } else {
            $option = New-CimSessionOption -Protocol Wsman
```

```
        }
        Try {
            Write-Verbose "Connecting to $computer over $protocol
            $params = @{'ComputerName'=$Computer
                        'SessionOption'=$option
                        'ErrorAction'='Stop'}
            $session = New-CimSession @params
            Write-Verbose "Querying from $computer"
            $os_params = @{'ClassName'='Win32_OperatingSystem'
                           'CimSession'=$session}
            $os = Get-CimInstance @os_params
            $cs_params = @{'ClassName'='Win32_ComputerSystem'
                           'CimSession'=$session}
            $cs = Get-CimInstance @cs_params
            $sysdrive = $os.SystemDrive
            $drive_params = @{'ClassName'='Win32_LogicalDisk'
                              'Filter'="DeviceId='$sysdrive'"
                              'CimSession'=$session}
            $drive = Get-CimInstance @drive_params
            $proc_params = @{'ClassName'='Win32_Processor'
                             'CimSession'=$session}
            $proc = Get-CimInstance @proc_params |
                    Select-Object -first 1
            Write-Verbose "Closing session to $computer"
            $session | Remove-CimSession
            Write-Verbose "Outputting for $computer"
            $obj = [pscustomobject]@{'ComputerName'=$computer
                       'OSVersion'=$os.version
                       'SPVersion'=$os.servicepackmajorversion
                       'OSBuild'=$os.buildnumber
                       'Manufacturer'=$cs.manufacturer
                       'Model'=$cs.model
                       'Procs'=$cs.numberofprocessors
                       'Cores'=$cs.numberoflogicalprocessors
                       'RAM'=($cs.totalphysicalmemory / 1GB)
                       'Arch'=$proc.addresswidth
                       'SysDriveFreeSpace'=$drive.freespace}
            Write-Output $obj
        } Catch {                 #B
        } #try/catch
    } #foreach
} #PROCESS
```

The idea is that if a problem happens with `New-CimSession`, *everything else is abandoned*. That should make sense: Without a session, you can't execute queries. Without queries, you can't generate results. Without results, you

can’t produce output. If one thing goes wrong, you need to quit.

Now, let’s focus on what you’ll do if an error—sorry, an *exception*—does occur:

```
} Catch {
    Write-Warning "FAILED $computer on $protocol"        #A
    # Did we specify protocol fallback?
    # If so, try again. If we specified logging,
    # we won't log a problem here - we'll let
    # the logging occur if this fallback also
    # fails
    If ($ProtocolFallback) {                        #B
        If ($Protocol -eq 'Dcom') {
            $newprotocol = 'Wsman'
        } else {
            $newprotocol = 'Dcom'
        } #if protocol
        Write-Verbose "Trying again with $newprotocol"
        $params = @{'ComputerName'=$Computer
                    'Protocol'=$newprotocol
                    'ProtocolFallback'=$False}
        If ($PSBoundParameters.ContainsKey('LogFailuresToPath')){
            $params += @{'LogFailuresToPath'=$LogFailuresToPath}
        } #if logging
        Get-MachineInfo @params
    } #if protocolfallback
    # if we didn't specify fallback, but we
    # did specify logging, then log the error,
    # because we won't be trying again
    If (-not $ProtocolFallback -and
        $PSBoundParameters.ContainsKey('LogFailuresToPath')){
        Write-Verbose "Logging to $LogFailuresToPath"
        $computer | Out-File $LogFailuresToPath -Append
    } # if write to log
} #try/catch
```

Here’s what’s happening:

1. Within the `Catch` block, you take the opportunity to write out a warning message for the benefit of the user. They can suppress these by adding `-Warning-Action SilentlyContinue` when running the command.
2. You look to see whether `-ProtocolFallback` was specified. If it was, you set `$newprotocol` to be whatever protocol you *weren’t* already

running with. You then set up a parameter hash table with your current computer name and that new protocol, and you specify `$False` for `ProtocolFallback`. Because you've *already fallen back* on the protocol, there's no sense in doing it again and falling into an endless loop. If you're running with `-LogFailuresToPath`, add that parameter to your hash table, and—here's the fun part—*call your function* using these parameters. Its output will become part of *your* output, giving you an easy way to try the other protocol without duplicating a bunch of code.

3. Look to see if you *aren't* running with `-ProtocolFallback`, but *are* running with `-LogFailuresToPath` so that you can log the failed computer name. Why don't you log the computer name, to begin with? If the *current* protocol fails, but you're asked to use protocol fallback, then your self-call to `Get-MachineInfo` will take care of the logging if *it* fails with the second protocol.

This is some complex logic—go through it a few times and make sure you understand it!

15.5 Capturing the Exception

The example so far hasn't cared what problem happened with `New-CimSession`; you have the same response to any possible failure. In some cases, you may want to know what exception happened. An easy way to do this is to specify the `-ErrorVariable`, or `-EV`, parameter and provide the name of a variable (remembering that `$` isn't part of a variable's name, so you omit the `$` here). Whatever exception happens will be placed in the specified variable for you to work with.

15.6 Handling exceptions for non-commands

What if you're running something—like a .NET Framework method—that doesn't have an `-ErrorAction` parameter? In *most* cases, you can run it in a `Try` block as is, because *most* of these methods will throw trappable, terminating exceptions if something goes wrong. The non-terminating exception thing is unique to PowerShell commands like functions and cmdlets.

But you *still* may have instances when you need to do this:

```
Try {
    $ErrorActionPreference = "Stop"
    # run something that doesn't have -ErrorAction
    $ErrorActionPreference = "Continue"
} Catch {
    # ...
}
```

This is your error handling of last resort. Basically, you're temporarily modifying `$ErrorActionPreference` for the duration of the one command (or whatever) for which you want to catch an exception. This isn't a common situation in our experience, but we figured we'd point it out.

15.7 Going further with exception handling

It's possible to have multiple `Catch` blocks after a given `Try` block, with each `Catch` dealing with a specific type of exception. For example, if a file deletion failed, you could react differently for a File Not Found or an Access Denied situation. To do this, you'll need to know the .NET Framework type name of each exception you want to call out separately. *The Big Book of PowerShell Error Handling* lists common ones and advice for figuring these out (for example, generating the error on your own in an experiment and then figuring out what the exception type name was). Broadly, the syntax looks like this:

```
Try {
    # something here generates an exception
} Catch [Exception.Type.One] {
    # deal with that exception here
} Catch [Exception.Type.Two] {
    # deal with the other exception here
} Catch {
    # deal with anything else here
} Finally {
    # run something else
}
```

Also shown in that example is the optional `Finally` block, which will always run after the `Try` or the `Catch`, whether or not an exception occurs.

Deprecated exception-handling

You may, in your internet travels, run across a `Trap` construct in PowerShell. This dates back to v1, when the PowerShell team frankly didn't have time to get `Try/ Catch` working, and `Trap` was the best short-term fix they could come up with. `Trap` is *deprecated*, meaning it's left in the product for backward compatibility, but you're not intended to use it in newly written code. For that reason, we're not covering it here. It *does* have some uses in global, “I want to catch and log any possible error” situations, but `Try/Catch` is considered a more structured, professional approach to exception handling, and we recommend that you stick with it.

15.8 Your turn

It’s time to deal with errors in your code.

15.8.1 Start here

This is where we left off at the end of chapter 14. You can use this as a starting point, or use your own results from that chapter.

Listing 15.1 Set TMServiceLogon

```
function Set-TMServiceLogon {
<#
.SYNOPSIS
Sets service login name and password.
.DESCRIPTION
This command uses either CIM (default) or WMI to
set the service password, and optionally the logon
user name, for a service, which can be running on
one or more remote machines. You must run this command
as a user who has permission to perform this task,
remotely, on the computers involved.
.PARAMETER ServiceName
The name of the service. Query the Win32_Service class
to verify that you know the correct name.
.PARAMETER ComputerName
One or more computer names. Using IP addresses will
fail with CIM; they will work with WMI. CIM is always
attempted first.
```

```
.PARAMETER NewPassword
A plain-text string of the new password.
.PARAMETER NewUser
Optional; the new logon user name, in DOMAIN\USER
format.
.PARAMETER ErrorLogFilePath
If provided, this is a path and filename of a text
file where failed computer names will be logged.
#>
    [CmdletBinding()]
    Param(
        [Parameter(Mandatory=$True,
                   ValueFromPipelineByPropertyName=$True)]
        [string]$ServiceName,
        [Parameter(Mandatory=$True,
                   ValueFromPipeline=$True,
                   ValueFromPipelineByPropertyName=$True)]
        [string[]]$ComputerName,
        [Parameter(ValueFromPipelineByPropertyName=$True)]
        [string]$NewPassword,
        [Parameter(ValueFromPipelineByPropertyName=$True)]
        [string]$NewUser,
        [string]$ErrorLogFilePath
    )
BEGIN{}
PROCESS{
    ForEach ($computer in $ComputerName) {
        Write-Verbose "Connect to $computer on WS-MAN"
        $option = New-CimSessionOption -Protocol Wsman
        $session = New-CimSession -SessionOption $option `
                                  -ComputerName $Computer
        If ($PSBoundParameters.ContainsKey('NewUser')) {
            $args = @{'StartName'=$NewUser
                      'StartPassword'=$NewPassword}
        } Else {
            $args = @{'StartPassword'=$NewPassword}
            Write-Warning "Not setting a new user name"
        }
        Write-Verbose "Setting $servicename on $computer"
        $params = @{'CimSession'=$session
                    'MethodName'='Change'
                    'Query'="SELECT * FROM Win32_Service " +
                            "WHERE Name = '$ServiceName'"
                    'Arguments'=$args}
        $ret = Invoke-CimMethod @params
        switch ($ret.ReturnValue) {
            0  { $status = "Success" }
```

```
            22 { $status = "Invalid Account" }
            Default { $status = "Failed: $($ret.ReturnValue)" }
        }
        $props = @{'ComputerName'=$computer
                   'Status'=$status}
        $obj = New-Object -TypeName PSObject -Property $props
        Write-Output $obj
        Write-Verbose "Closing connection to $computer"
        $session | Remove-CimSession
    } #foreach
} #PROCESS
END{}
} #function
```

15.8.2 Your task

Your job is to add error handling to your tool. Remember, in the event of an error, the design calls for you to automatically try the DCOM protocol, because you're always starting with the WSman protocol. If a computer fails, you should log it *only* if logging was specified, and *only* after *both* protocols have been attempted.

Your task is made a little more difficult by the fact that the parameter design doesn't include a parameter for the protocol. That means you can't just call your own function again with a different protocol parameter! Instead, you'll have to write a *loop* that will execute your code up to two times. One such loop might look something like this:

```
Do {
    # code goes here
} Until ($something -eq 'else')
```

This kind of loop will always execute its contents at least once. It will continue executing *until* the condition specified at the end of the loop is `$True`. See if you can find the necessary logic to add to your script.

15.8.3 Our take

Here's what we came up with.

Listing 15.2 Our solution

```
function Set-TMServiceLogon {
<#
.SYNOPSIS
Sets service login name and password.
.DESCRIPTION
This command uses either CIM (default) or WMI to
set the service password, and optionally the logon
user name, for a service, which can be running on
one or more remote machines. You must run this command
as a user who has permission to peform this task,
remotely, on the computers involved.
.PARAMETER ServiceName
The name of the service. Query the Win32_Service class
to verify that you know the correct name.
.PARAMETER ComputerName
One or more computer names. Using IP addresses will
fail with CIM; they will work with WMI. CIM is always
attempted first.
.PARAMETER NewPassword
A plain-text string of the new password.
.PARAMETER NewUser
Optional; the new logon user name, in DOMAIN\USER
format.
.PARAMETER ErrorLogFilePath
If provided, this is a path and filename of a text
file where failed computer names will be logged.
#>
    [CmdletBinding()]
    Param(
        [Parameter(Mandatory=$True,
                   ValueFromPipelineByPropertyName=$True)]
        [string]$ServiceName,
        [Parameter(Mandatory=$True,
                   ValueFromPipeline=$True,
                   ValueFromPipelineByPropertyName=$True)]
        [string[]]$ComputerName,
        [Parameter(ValueFromPipelineByPropertyName=$True)]
        [string]$NewPassword,
        [Parameter(ValueFromPipelineByPropertyName=$True)]
        [string]$NewUser,
        [string]$ErrorLogFilePath
    )
BEGIN{}
PROCESS{
    ForEach ($computer in $ComputerName) {
        Do {
            Write-Verbose "Connect to $computer on WS-MAN"
            $protocol = "Wsman"
```

```
            Try {
                $option = New-CimSessionOption -Protocol $protoco
                $session = New-CimSession -SessionOption $option
                                          -ComputerName $Computer
                                          -ErrorAction Stop
                If ($PSBoundParameters.ContainsKey('NewUser')) {
                    $args = @{'StartName'=$NewUser
                              'StartPassword'=$NewPassword}
                } Else {
                    $args = @{'StartPassword'=$NewPassword}
                    Write-Warning "Not setting a new user name"
                }
                Write-Verbose "Setting $servicename on $computer"
                $params = @{'CimSession'=$session
                            'MethodName'='Change'
                            'Query'="SELECT * FROM Win32_Service
                                    "WHERE Name = '$ServiceName'"
                            'Arguments'=$args}
                $ret = Invoke-CimMethod @params
                switch ($ret.ReturnValue) {
                    0  { $status = "Success" }
                    22 { $status = "Invalid Account" }
                    Default { $status = "Failed: $($ret.ReturnVal
                }
                $props = @{'ComputerName'=$computer
                           'Status'=$status}
                $obj = New-Object -TypeName PSObject -Property $p
                Write-Output $obj
                Write-Verbose "Closing connection to $computer"
                $session | Remove-CimSession
            } Catch {
                # change protocol - if we've tried both
                # and logging was specified, log the computer
                Switch ($protocol) {
                    'Wsman' { $protocol = 'Dcom' }
                    'Dcom'  {
                        $protocol = 'Stop'
                        if ($PSBoundParameters.ContainsKey('Error
                            Write-Warning "$computer failed; logg
➥ $ErrorLogFilePath"
                            $computer | Out-File $ErrorLogFilePat
                        } # if logging
                     }
                } #switch
            } # try/catch
        } Until ($protocol -eq 'Stop')
    } #foreach
} #PROCESS
```

```
END{}
} #function
```

Again, apologies for any word-wrapping; consult the downloadable code samples at www.manning.com/books/learn-powershell-scripting-in-a-month-of-lunches for a well-formatted version.

In this revision, we changed `New-CimSessionOption` to use a variable for the protocol. We manually set this to “Wsman” to begin with, but in the event of a failure, we switch it to “Dcom.” If it fails again, we set the protocol to Stop, which triggers an exit from the `Do` loop; we also take the opportunity to log the computer name, if we’re asked to do so.

16 Filing out a Manifest

Up to this point, you've been relying on the PowerShell magic to make your commands—which are contained within a module—run. It's worth digging into this magic a bit because there's a ton more you can do with it.

16.1 Module execution order

When PowerShell goes looking for modules, it first enumerates all the folders listed in the PSModulePath environment variable. Each folder under each of those paths is considered to be a potential module.

Within a module folder, PowerShell looks for the following:

1. A .psd1 file having the same filename as the module's folder name. This is a *module manifest* and tells the shell what else needs to be loaded.
2. A .dll file having the same filename as the module's folder name. This is a *compiled* or *binary* module, usually written in C#.
3. A .psm1 file has the same filename as the module's folder name. This is a *script module*.

You've been using number 3 on that list. If you create a file named \Documents\ PowerShell\Modules\MyPSModule\MyPSModule.psm1, then you've created a script module named "MyPSModule," and whatever functions are in that .psm1 file will become commands that PowerShell can run. This is a super quick and easy way to get a module up and running, but it has some disadvantages.

First, the module can't easily take care of things like versioning, establishing prerequisites, and loading supporting files (like custom formatting views, which we'll get to later in this book). As your modules become more complex and you iterate them over time, you'll need all of these things.

Second, a script module alone, as it becomes larger and contains more commands, can slow down PowerShell—even if you're not using the

module. That’s because, at launch time, PowerShell has to figure out what modules you have and what commands they contain. For a standalone script module, that means *loading and parsing the entire file* to see what functions are lurking within. That parsing takes time; and for large modules, or if you have a lot of them, that time can become significant—and it’s a hit every time you open a new PowerShell window.

A manifest—which takes advantage of item 1 on the earlier list—solves these problems. It gives you the ability to specify a great deal of additional information about your module; and, used correctly, it can vastly speed up PowerShell’s module-discovery time.

16.2 Creating a new manifest

Creating a new, very basic, manifest is easy. Just change to your module folder, and run `New-ModuleManifest`. Specify a filename for the manifest (which should be the same as the module folder’s name, followed by the .psd1 filename extension), and specify your existing .psm1 script module as the *root module*:

```
New-ModuleManifest –Path MyModule.psd1 –Root ./MyModule.psm1
```

WARNING

PowerShell does exactly nothing to verify that what you’ve typed is correct. A typo in either of these paths will create a nonfunctional manifest and can prevent your entire module from loading until you fix your mistakes.

That example assumes you’re in a `MyModule` directory, making the official name of the module MyModule. The result is something like this (which you can, and should, create on your own so that you can follow along). The automatically generated comments for each section help explain:

```
#
# Module manifest for module 'MyModule'
#
# Generated by: User
#
# Generated on: 7/23/2023
```

```
#

@{

# Script module or binary module file associated with this manife
RootModule = './MyModule.psm1'

# Version number of this module.
ModuleVersion = '0.0.1'

# Supported PSEditions
# CompatiblePSEditions = @()

# ID used to uniquely identify this module
GUID = 'ce7775f9-e168-48d6-8e8f-f4c04696d673'

# Author of this module
Author = 'User'

# Company or vendor of this module
CompanyName = 'Unknown'

# Copyright statement for this module
Copyright = '(c) User. All rights reserved.'

# Description of the functionality provided by this module
# Description = ''

# Minimum version of the PowerShell engine required by this modul
# PowerShellVersion = ''

# Name of the PowerShell host required by this module
# PowerShellHostName = ''

# Minimum version of the PowerShell host required by this module
# PowerShellHostVersion = ''

# Minimum version of Microsoft .NET Framework required by this mo
# DotNetFrameworkVersion = ''

# Minimum version of the common language runtime (CLR) required b
# ClrVersion = ''

# Processor architecture (None, X86, Amd64) required by this modu
# ProcessorArchitecture = ''

# Modules that must be imported into the global environment prior
```

```
# RequiredModules = @()

# Assemblies that must be loaded prior to importing this module
# RequiredAssemblies = @()

# Script files (.ps1) that are run in the caller's environment pr
# ScriptsToProcess = @()

# Type files (.ps1xml) to be loaded when importing this module
# TypesToProcess = @()

# Format files (.ps1xml) to be loaded when importing this module
# FormatsToProcess = @()

# Modules to import as nested modules of the module specified in
# NestedModules = @()

# Functions to export from this module, for best performance, do
FunctionsToExport = '*'

# Cmdlets to export from this module, for best performance, do no
CmdletsToExport = '*'

# Variables to export from this module
VariablesToExport = '*'

# Aliases to export from this module, for best performance, do no
AliasesToExport = '*'

# DSC resources to export from this module
# DscResourcesToExport = @()

# List of all modules packaged with this module
# ModuleList = @()

# List of all files packaged with this module
# FileList = @()

# Private data to pass to the module specified in RootModule/Modu
PrivateData = @{

    PSData = @{

        # Tags applied to this module. These help with module dis
        # Tags = @()

        # A URL to the license for this module.
```

```
        # LicenseUri = ''

        # A URL to the main website for this project.
        # ProjectUri = ''

        # A URL to an icon representing this module.
        # IconUri = ''

        # ReleaseNotes of this module
        # ReleaseNotes = ''

        # Prerelease string of this module
        # Prerelease = ''

        # Flag to indicate whether the module requires explicit u
        # RequireLicenseAcceptance = $false

        # External dependent modules of this module
        # ExternalModuleDependencies = @()

    } # End of PSData hashtable

} # End of PrivateData hashtable

# HelpInfo URI of this module
# HelpInfoURI = ''

# Default prefix for commands exported from this module. Override
# DefaultCommandPrefix = ''

}
```

Note

We're assuming you'll be doing this on a system with PowerShell. The same holds for Windows PowerShell but the manifest that is created may look a little different so don't be alarmed.

16.3 Examining the manifest

Let's take a look at a few key sections in a bit more detail. It's worth mentioning that almost everything here can be specified in advance, using the parameters of `New-ModuleManifest`. Often, though, we just create the bare-

bones manifest shown here and then edit it in VS Code when we want to add things to the module.

16.3.1 Metadata

You’ll notice a great deal of *metadata*, or data about the module itself, in the manifest:

- `ModuleVersion` is something you should get in the habit of filling out, using the standard Microsoft w.x.y.z version notation. If you plan to submit modules to PowerShellGallery.com, this is mandatory in your manifest.
- A globally unique identifier (`GUID`) is a requirement and is generated automatically. This uniquely identifies your module.
- `Author` should be your name, and `CompanyName` should be your organization, if appropriate. If you’re submitting to PowerShellGallery, Author is mandatory.
- `Copyright` and `Description` are optional, but you should include a `Description` for PowerShellGallery submissions (it may become mandatory at some point).
- `ModuleList` is a list of all submodules that your module includes—basically, the names of any .psm1 files. This doesn’t *do* anything—it’s just here for documentation purposes, and it’s rare to see this used.
- `FileList` is similar to `ModuleList`—it’s just a way to document all the files included in the module.

16.3.2 The root module

This is the .psm1 file that contains either all of your functions or code to dot source the required script files. It’s assumed that the .psm1 file is in the same directory as the manifest. PowerShell won’t complain if you leave this empty, but your module also won’t behave as you expect.

16.3.3 Prerequisites

Several manifest properties help PowerShell figure out whether your module can be run on a given computer:

- `CompatiblePSEditions` This tells the engine if this module can run in PowerShell or Windows PowerShell. The two options are `Core` and `Desktop`.
- `PowerShellVersion` specifies the minimum version of PowerShell needed for the module to run.
- `PowerShellHostName` and `PowerShellHostVersion` describe the host application and version in which your module runs. This can be used to restrict modules to only certain hosting situations, such as "Console-Host" or some other environment.
- `DotNetFrameworkVersion` and `CLRVersion` describe any minimum version requirements of the .NET Framework or the Framework's Common Language Runtime (CLR).
- `ProcessorArchitecture` documents any platform dependencies, such as "X86" or "Amd64."
- `RequiredModules` is an array of module names that must be imported *before* your module's commands are loaded. PowerShell will attempt to load these for you and will fail—and refuse to load your module—if for some reason it can't load these prerequisites.
- `NestedModules` is a little different than `RequiredModules`. Modules included in `RequiredModules` are loaded into the global session, which means they won't unload when your module is unloaded. Modules in `NestedModules` are visible *only to your module* and can't be seen or used by the person who loaded your module (unless that person also manually imports them).

16.3.4 Scripts, types, and formats

You can specify a number of supporting elements for your module. These are loaded and unloaded along with the module. Each of these elements is an array, which means you can specify zero or more elements to load:

- `ScriptsToProcess` lists PowerShell scripts (.ps1 files) that should be run *before* your module is loaded. This is a little unusual to see, but you can use it to run things like setup tasks. It's also possible to put those setup commands into the module .psm1 file, although breaking them into a separate preload script can help make the code easier to read and maintain.

- `TypesToProcess` is a list of PowerShell Extensible Type System (ETS) extensions—usually .ps1xml files—that your module needs to load.
- `FormatsToProcess` is a list of PowerShell formatting view files—usually .format-.ps1xml files—that your module needs to load. We'll cover these later in this book.

Although you can provide full paths to any of these, the convention is to include each supporting element in the module's folder and to refer to `./filename` in the array.

16.3.5 Exporting members

This is where you can save PowerShell some load time. Rather than forcing it to parse your entire script module and figure out what functions exist, you can declare those functions as being exported from the module. There's a side effect: Any functions you *don't* export become private to the module. That means anything else within the module can see and use those functions, but the person who loaded your module *won't* see them or be able to use them. You can use this feature to create helper functions that are used by other commands in your module but that aren't exposed to anyone else.

You can export five types of things. Each of these is an array within the manifest:

- `FunctionsToExport` holds functions you want people to be able to use as commands.
- `CmdletsToExport` won't be used in a script module—this is the equivalent of `FunctionsToExport` when publishing a compiled module.
- `VariablesToExport` holds module-level variables that you want to be added to the global scope. This is a good way to publish variables that set things like log filenames, database connection strings, and so on.
- `AliasesToExport` holds aliases that you define in your module (using `New-Alias`) and that you want to be exposed when your module is loaded.
- `DscResourcesToExport` is a special list related to building Desired State Configuration (DSC) resource modules. This is a special type of PowerShell tool that we aren't covering in this book.

As a note, it’s legal for most of these to just specify `*`, meaning “export everything.” Sadly, that doesn’t help PowerShell in a performance sense, because it still forces PowerShell to open and parse the entire script module to see exactly what “everything” entails. As a best practice, avoid using `*`, and take the time to explicitly list exported items.

Exporting exceptions

You need to be aware of a few exporting exceptions. If you’re creating a script module, as opposed to a binary, compiled module—which is exporting and which needs to export variables and aliases—then you must use `Export-ModuleMember` at the end of your .psm1 file. There’s no harm in using `Export-ModuleMember` to list your functions here as well as in the manifest. You might have a line like this at the end of your .psm1 file:

```
Export-modulemember -function Get-Foo,Set-Foo -variable myfoo -al
```

For the sake of consistency, you might get in the habit of using `Export-Module-Member` and the manifest. PowerShell is a very active product, and you never know when a future version will allow exporting variables and aliases in a manifest. Cover all your bases.

16.4 Your turn

We’re going to give you a module (as a .psm1 file) and ask you to create a corresponding manifest. This shouldn’t take long!

16.4.1 Start here

The following listing shows the contents of MyTools.psm1, a script module.

Listing 16.1 MyTools.psm1 script module

```
function Get-TMIPInfo {
    [CmdletBinding()]
    Param(
        [Parameter(Mandatory=$True,
                   ValueFromPipeline=$True)]
```

```
        [string[]]$ComputerName
    )
    BEGIN {}
    PROCESS {
        ForEach ($comp in $computername) {
            Write-Verbose "Connecting to $comp"
            $s = New-CimSession -ComputerName $comp
            $adapters = Get-NetAdapter -CimSession $s |
                        Where Status -ne 'Disconnected'
            ForEach ($adapter in $adapters) {
                Write-Verbose "  Interface $($adapter.interfacein
                $addresses = Get-NetIPAddress -InterfaceIndex $ad
                                              -CimSession $s
                ForEach ($address in $addresses) {
                    $props = @{'ComputerName'=$Comp
                               'Index'=$adapter.interfaceindex
                               'Name'=$adapter.interfacealias
                               'MAC'=$adapter.macaddress
                               'IPAddress'=$address.ipaddress}
                    New-Object -TypeName PSObject -Property $prop
                } #foreach address
            } #adapter
            $s | Remove-CimSession
        } #foreach computer
    } #process
    END {}
} #function
```

We assume that you've saved this as \Documents\PowerShell\Modules\MyTools\MyTools.psm1.

16.4.2 Your task

Create a manifest for the MyTools module. In it, do the following:

- Specify at least a version, a description, and an author.
- Specify MyTools.psm1 as the root module.
- Export the Get-TMIPInfo function.

16.4.3 Our take

We ran this command (we've prettied up the formatting here for readability; we typed it as one long line of text):

```
New-ModuleManifest -Path MyTools.psd1
                   -RootModule ./MyTools.psm1
                   -ModuleVersion 1.0.0.0
                   -Author 'Jeff and Don'
                   -Description 'A test module'
                   -FunctionsToExport @('Get-TMIPInfo')
```

For the sake of the book, we’ve truncated some of the comments. The result is something like this:

```
#
# Module manifest for module 'MyModule'
#
# Generated by: User
#
# Generated on: 6/19/2017
#
@{
# Script module or binary module file associated with this manife
RootModule = 'MyModule.psm1'
# Version number of this module.
ModuleVersion = '1.0'
# Supported PSEditions
# CompatiblePSEditions = @()
# ID used to uniquely identify this module
GUID = 'ea4d119b-6bcf-4540-a389-67cf7d261726'
# Author of this module
Author = 'User'
# Company or vendor of this module
CompanyName = 'Unknown'
# Copyright statement for this module
Copyright = '(c) 2017 User. All rights reserved.'
# Description of the functionality provided by this module
# Description = ''
# Minimum version of the Windows PowerShell engine required by th
# PowerShellVersion = ''
# Name of the Windows PowerShell host required by this module
# PowerShellHostName = ''
# Minimum version of the Windows PowerShell host required by this
# PowerShellHostVersion = ''
# Minimum version of Microsoft .NET Framework required by this mo
# DotNetFrameworkVersion = ''
# Minimum version of the common language runtime (CLR) required b
# CLRVersion = ''
# Processor architecture (None, X86, Amd64) required by this modu
# ProcessorArchitecture = ''
# Modules that must be imported into the global environment prior
```

```
# RequiredModules = @()
# Assemblies that must be loaded prior to importing this module
# RequiredAssemblies = @()
# Script files (.ps1) that are run in the caller's environment pr
# ScriptsToProcess = @()
# Type files (.ps1xml) to be loaded when importing this module
# TypesToProcess = @()
# Format files (.ps1xml) to be loaded when importing this module
# FormatsToProcess = @()
# Modules to import as nested modules of the module specified in
# NestedModules = @()
# Functions to export from this module, for best performance, do
FunctionsToExport = @('Get-TMIIPInfo')
# Cmdlets to export from this module, for best performance, do no
CmdletsToExport = '*'
# Variables to export from this module
VariablesToExport = '*'
# Aliases to export from this module, for best performance, do no
AliasesToExport = '*'
# DSC resources to export from this module
# DscResourcesToExport = @()
# List of all modules packaged with this module
# ModuleList = @()
# List of all files packaged with this module
# FileList = @()
# Private data to pass to the module specified in ...
PrivateData = @{
    PSData = @{
        # Tags applied to this module. These help with module dis
        # Tags = @()
        # A URL to the license for this module.
        # LicenseUri = ''
        # A URL to the main website for this project.
        # ProjectUri = ''
        # A URL to an icon representing this module.
        # IconUri = ''
        # ReleaseNotes of this module
        # ReleaseNotes = ''
    } # End of PSData hashtable
} # End of PrivateData hashtable
# HelpInfo URI of this module
# HelpInfoURI = ''
# Default prefix for commands exported from this module. Override
# DefaultCommandPrefix = ''
}
```

17 Changing your brain when it comes to scripting

Let's pause our ongoing narrative for a moment. In the previous chapters, our primary focus was creating tools that align with PowerShell's established conventions and practices. While this approach has its merits, there are instances where the most effective way to convey a message is by highlighting its contrast.

NOTE

This is our special Bonus Double Chapter; feel free to take your time as you read through this chapter. It's essential to grasp the underlying rationale behind our discussion fully. If certain aspects still need clarification, feel free to engage with the community on PowerShell.org and ask any questions. It's worth emphasizing that the concepts explored in this chapter stand as the core pillars of this book; everything else is essentially a means to implement and reinforce these foundational ideas. If you intend to progress to more advanced scripting, as covered in "The PowerShell Scripting & Toolmaking Book" (https://leanpub.com/powershell-scripting-toolmaking), a solid understanding of the principles in this chapter is an absolute necessity.

17.1 Example 1

Let's consider a forum post from PowerShell.org, which we've referenced with permission from its original author. The goals were to list the sizes of each User's home folder and show any orphan folders—folders that no longer corresponded to an AD user. The author posted this code.

Listing 17.1 Typical PowerShell

```
$UserNames = Get-ADUser -Filter * -SearchBase `
"OU=NAME_OF_OU_WITH_USERS3,OU=NAME_OF_OU_WITH_USERS2,
OU=NAME_OF_OU_WITH_USERS1,DC=DOMAIN_NAME,DC=COUNTRY_CODE" |
```

```
Select -ExpandProperty samaccountname
$UserRegex = ($UserNames | ForEach{[RegEx]::Escape($_)}) -join "|
$myArray = (Get-ChildItem -Path "\\file2\Felles\Home\*" -Director
Where{$_.Name -notmatch $UserRegex})
#$myArray
foreach ($mapper in $myArray) {
    #Param ($mapper = $(Throw "no folder name specified"))
    # calculate folder size and recurse as needed
    $size = 0
    Foreach ($file in $(ls $mapper -recurse)){
    If (-not ($file.psiscontainer)) {
        $size += $file.length
        }
    }
    # return the value and go back to caller
    echo $size
}
```

17.1.1 The critique

Now, this isn't meant to beat up on the original author. People learn different things at different times and arrive at their code's condition through various paths. Let's take the code for what it is:

- If asked to solve this problem, we'd write this as two functions, not as one script. One function would sum up folder sizes, which is a useful function in many scenarios. Another would figure out which folders were orphans.
- We'd also take a more PowerShell-native approach, avoiding things like `echo`. Instead, we'd aim to output objects because those could be piped to commands that made them into CSV files, HTML reports, and lots more. On most systems, `echo` should be an alias for `Write-Output`, which means objects will be written to the pipeline. But using the alias doesn't make that clear, and someone could have used `echo` as an alias for `Write-Host`—and then you'd be back to not having objects in the pipeline.
- We'd probably make more use of native PowerShell commands because they tend to run a smidge faster than a script.
- To maximize reuse, we'd try to keep our functions as generic and non-context-specific as possible. This means no hard-coded names or paths.

One thing to remember is that, in Windows, *folders don't have a size*. You have to get all the files within that folder instead and add up *their* sizes.

17.1.2 Our take

Here's our first function. We aren't going to explain each line in detail. You can (and should) try the code yourself. Notice that we're explicitly outputting an empty object if a folder doesn't exist.

Listing 17.2 Get-FolderSize

```
function Get-FolderSize {
    [CmdletBinding()]
    Param(
        [Parameter(Mandatory=$True,
                   ValueFromPipeline=$True,
                   ValueFromPipelineByPropertyName=$True)]
        [string[]]$Path
    )
    BEGIN {}
    PROCESS {
        ForEach ($folder in $path) {
            Write-Verbose "Checking $folder"
            if (Test-Path -Path $folder) {
                Write-Verbose " + Path exists"
                $params = @{'Path'=$folder
                            'Recurse'=$true
                            'File'=$true}
                $measure = Get-ChildItem @params |
                           Measure-Object -Property Length -Sum
                [pscustomobject]@{'Path'=$folder
                                  'Files'=$measure.count
                                  'Bytes'=$measure.sum}
            } else {
                Write-Verbose " - Path does not exist"
                [pscustomobject]@{'Path'=$folder
                                  'Files'=0
                                  'Bytes'=0}
            } #if folder exists
        } #foreach
    } #PROCESS
    END {}
} #function
```

The results of our first function look like this:

```
Path                                              Files    Bytes
----                                              -----    -----
C:\Get-DiskInfo                                     35    44101
C:\nope                                              0        0
```

We could pipe that to `Select-Object` to turn the Bytes count into another unit, like megabytes. Still, we feel it's important for our tool to output the lowest-level information possible to maximize its utility. Notice that we didn't test this against home folders per se; we want this to be a generic folder-size-adding-up function. Later, we'll write a controller script to put this function to more specific business use, like summing up user home folder sizes.

Now, we will write a second function to deal with orphan folders. This will incorporate our Get-FolderSize function. We assume this function has already been loaded into the PowerShell session. This particular tool is a bit more task-specific because it needs to understand our need to identify orphaned home folders.

Listing 17.3 Get-UserHomeFolderInfo

```
function Get-UserHomeFolderInfo {
    [CmdletBinding()]
    Param(
        [Parameter(Mandatory=$True)]
        [string]$HomeRootPath
    )
    BEGIN {}
    PROCESS {
        Write-Verbose "Enumerating $HomeRootPath"
        $params = @{'Path'=$HomeRootPath
                    'Directory'=$True}
        ForEach ($folder in (Get-ChildItem @params)) {      #A
            Write-Verbose "Checking $($folder.name)"
            $params = @{'Identity'=$folder.name
                        'ErrorAction'='SilentlyContinue'}
            $user = Get-ADUser @params                    #B
            if ($user) {
                Write-Verbose " + User exists"
                $result = Get-FolderSize -Path $folder.fullname
                [pscustomobject]@{'User'=$folder.name
```

```
                                    'Path'=$folder.fullname
                                    'Files'=$result.files
                                    'Bytes'=$result.bytes
                                    'Status'='OK'}
            } else {
                Write-Verbose " - User does not exist"
                [pscustomobject]@{'User'=$folder.name
                                    'Path'=$folder.fullname
                                    'Files'=0
                                    'Bytes'=0
                                    'Status'="Orphan"}
            } #if User exists
        } #foreach
    } #PROCESS
    END {}
}
```

Here, we're taking a root location that contains home folders, going through them one at a time, and checking to see whether a corresponding AD user exists. We output a blank object with an Orphan Status property if one doesn't. We could easily use `Where-Object` to filter for just the orphans so that someone could deal with those. If the User exists, we use Get-FolderSize to get the size info and output the same object. This time, the object is fully populated with an OK status. Either way, writing out the same kind of object ensures consistent output and maximizes the reusability of the information. You'll find this code in the downloadable samples at https://www.manning.com/books/learn-powershell-scripting-in-a-month-of-lunches, under this chapter's folder.

17.1.3 Thinking beyond the literal

The idea here is to take a given task and break it down. In the original forum post, the source data was "all users in AD," which created some challenges regarding finding orphan folders. In our approach, we use the list of folders as the source data and check each against AD. That won't tell us if we have users *without* home folders, but that wasn't a stated problem (and, in most cases, we expect users would bring it up to the help desk if they didn't have a home folder).

We took the one generic portion of the task and wrote it out as its tool: Get-FolderSize. We ensured it was helpful on its own, accepting pipeline input

and such, even though that's not how Get-UserHomeFolderInfo uses it. We incorporated verbose output that will make each function a bit easier to follow and debug, if necessary. And, because we've used functions, each task is tightly scoped and does just one thing, making each function less complex, easier to debug, and easier to understand and maintain.

17.2 Example 2

Below is an example of a script that will notify a user via email when their password is close to expiring. This is a very long script so we suggest you download it **(url here)**

Listing 17.4 PasswordChangeNotification.ps1

```
<#                  #A
This script will connection to Azure AD via Microsoft Graph and n
#>
Connect-MgGraph -ClientId 'YOUR_CLINET_ID' -TenantId 'YOUR_TENANT


#Domain's password experation in Days      #C
$PasswordValidDay = get-mgdomain -DomainId PowerShell.org | selec

# Check the user's password expiration date
$today = Get-Date
$allUsers = get-mguser -All -Property lastPasswordChangeDateTime,
Where-Object {$_.PasswordPolicies -contains "DisablePasswordExpir

foreach ($user in $allUsers) {          #E
    $passwordExpirationDate = $user.LastPasswordChangeDateTime +

    # Define the notification threshold (e.g., 7 days before pass
    $notificationThreshold = 7

    # Calculate the number of days until password expiration
    $daysUntilExpiration = ($passwordExpirationDate - $today).Day

    if ($daysUntilExpiration -le $notificationThreshold) {
        #Send Email using Graph API            #F
        $params = @{
            Message         = @{
                Subject       = "Your Passord is About to Expire"
                Body          = @{
```

```
                    ContentType = 'HTML'
                    Content     = "Your password will expire on $
                }
                ToRecipients  = @(
                    @{
                        EmailAddress = @{
                            Address = $user.mail
                        }
                    }
                )
            }
            SaveToSentItems = $true
        }
        # Send message
        Send-MgUserMail -UserId $from -BodyParameter $params
    } else {
        Write-Host "Password is not yet expired. Days until expir
    }

}
```

17.2.1 The walkthrough

Let's run through this script in major sections, to get you situated with what's happening. We'll repeat a few lines of code inline so that you don't have to keep flipping back and forth:

A. This script works well, but its not a tool. First, there is very little help to find on how to use the script.

B. Next, we connect to our Graph API Application in Entra ID (Formally Azure AD) giving our Client (Application) ID and our Tenant ID. Connect-MgGraph -ClientId 'YOUR_CLINET_ID' -TenantId 'YOUR_TENANT_ID'

C. A few lines of code to check the date `$today = Get-Date`

D. The next block of code checks what the password expiration policy is set for at the domain level. Then we gather all the users in our directory whose password policy is not set to “Never Expires.”

```
$allUsers = get-mguser -All -Property ` lastPasswordChangeDateTim
```

E. The next step in the code is to loop through the array. In the big mess of code, we are comparing two dates. Today's date minus the last time a user changed their password. If it is less than our threshold (7 days).

F. Next Up is to gather all the information we need to send the user an email that their password is going to expire soon $params = @{

```
            Message         = @{
                Subject       = "Your Passord is About to Expire"
                Body          = @{
                    ContentType = 'HTML'
                    Content     = "Your password will expire on $
                }
                ToRecipients  = @(
                    @{
                        EmailAddress = @{
                            Address = $user.mail
                        }
                    }
                )
            }
            SaveToSentItems = $true
        }
```

G. And finally, we send the email suing the Graph API `Send-MgUserMail -UserId $from -BodyParameter $params`

17.2.2 Our take

This is a good example of what we call a *monolithic script*. That is, it's doing more than one task as part of a larger process, but it's performing all those tasks in a single sequence, rather than the tasks being modularized into tools. This kind of script takes a good amount of work to write and can be tough to debug because there's so much going on purely in memory. What we like to do with toolmaking is create smaller, self-contained tools, each of which represents a kind of boundary. That way, each tool can be written and tested individually, making both coding and debugging a lot easier.

The first thing you will notice is that we broke this down into four different functions. `Connect-MyMgGraph`, `Get-PasswordExpirationWindow`, `Check-PasswordExpiration`, and `Send-PasswordExpirationNotification`. Let us

look at the first function and break it down. We have two parameters that are mandatory, the Client ID for your application you made and the Tenant ID for your Microsoft Entra ID (Formally Azure AD) Tenant. Then we use the command `Connect-MgGraph` to create the connection to the Graph API.

```
function Connect-MyMgGraph {
    [CmdletBinding()]
    param (
        [Parameter(Mandatory = $true)]
        [string]$ClientId,
        [Parameter(Mandatory = $true)]
        [string]$TenantId
    )

    # Connect to Microsoft Graph here with the given credentials
    Connect-MgGraph -ClientId $ClientId -TenantId $TenantId -NoWe

    Write-Host "Connected to Microsoft Graph"
```

The Next function is `Get-PasswordExpirationWindow`. This function is small but remember we are trying to break down our code in reusable pieces. It has a single parameter that is mandatory, and this is the Domain ID. Using the Graph API it looks to see what the organization password expiration policy is set to.

```
function Get-PasswordExpirationWindow {
    [CmdletBinding()]
    param (
        [Parameter(Mandatory = $true)]
        [string]$DomainId
    )

    $PasswordValidDay = Get-MgDomain -DomainId $DomainId | Select
    return $PasswordValidDay
```

The next function is Check-`PasswordExpiration` which is the bulk of our code. It gathers a list (array) of all users that do not have a password policy of DisablePasswordExpiration. Then we look at the date of the last time the password was set, and subtract that from today’s date. If it is less than our threshold then we call our last function Send-PasswordExpirationNotification to email the user that their password is about to expire.

```
function Check-PasswordExpiration {
```

```
    [CmdletBinding()]
    param (
        [Parameter(Mandatory = $true)]
        [int]$NotificationThreshold,
        [Parameter(Mandatory = $true)]
        [string]$DomainId
    )

    $today = Get-Date
    $allUsers = Get-MgUser -All -Property lastPasswordChangeDateT

    foreach ($user in $allUsers) {
        $passwordExpirationDate = $user.LastPasswordChangeDateTim

        $daysUntilExpiration = ($passwordExpirationDate - $today)

        if ($daysUntilExpiration -le $NotificationThreshold) {
            Send-PasswordExpirationNotification -User $user -Expi
        }
        else {
            Write-Host "Password is not yet expired. Days until e
        }
    }
}
```

Our last function is Send-PasswordExpirationNotification which uses the Graph API to send an email to the user letting them know that their password is about to expire.

```
function Send-PasswordExpirationNotification {
    [CmdletBinding()]
    param (
        [Parameter(Mandatory = $true)]
        [PSCustomObject]$User,
        [Parameter(Mandatory = $true)]
        [datetime]$ExpirationDate
    )

    $params = @{
        Message         = @{
            Subject      = "Your Password is About to Expire"
            Body         = @{
                ContentType = 'HTML'
                Content     = "Your password will expire on $Expi
            }
            ToRecipients = @(
```

```
                @{
                    EmailAddress = @{
                        Address = $User.mail
                    }
                }
            )
        }
        SaveToSentItems = $true
    }

    # Send the email using the Graph API
    Send-MgUserMail -UserId $from -BodyParameter $params
}
```

The last two lines of code simply call our functions. The first calls our `Connect-MyMgGraph` function to connect to the the Graph API

```
Connect-MyMgGraph -ClientId 'YOUR_CLIENT_ID' -TenantId 'YOUR_TENA
```

And lastly, we call our `Check-PasswordExpiration` function, and we are sending it a threshold of 7 days and our Domain name.

```
Check-PasswordExpiration -NotificationThreshold 7 -DomainID "Your
```

Listing 17.5 Revised password expiration code

```
<#
.SYNOPSIS
   Connects to the Microsoft Graph API with the provided client I
.DESCRIPTION
   This function establishes a connection to the Microsoft Graph 
.PARAMETER ClientId
   The client ID for your application.
.PARAMETER TenantId
   The tenant ID associated with your organization.
#>
function Connect-MyMgGraph {
    [CmdletBinding()]
    param (
        [Parameter(Mandatory = $true)]
        [string]$ClientId,
        [Parameter(Mandatory = $true)]
        [string]$TenantId
    )
```

```
    # Connect to Microsoft Graph here with the given credentials
    Connect-MgGraph -ClientId $ClientId -TenantId $TenantId -NoWe

    Write-Host "Connected to Microsoft Graph"
}

<#
.SYNOPSIS
   Retrieves the password expiration window for a specific domain
.DESCRIPTION
   This function retrieves the password expiration window (in day
.PARAMETER DomainId
   The ID of the domain for which you want to get the password ex
#>
function Get-PasswordExpirationWindow {
    [CmdletBinding()]
    param (
        [Parameter(Mandatory = $true)]
        [string]$DomainId
    )

    $PasswordValidDay = Get-MgDomain -DomainId $DomainId | Select
    return $PasswordValidDay
}

<#
.SYNOPSIS
   Checks and notifies users of password expiration.
.DESCRIPTION
   This function checks the password expiration for all users and
.PARAMETER NotificationThreshold
   The number of days before password expiration to send notifica
#>
function Check-PasswordExpiration {
    [CmdletBinding()]
    param (
        [Parameter(Mandatory = $true)]
        [int]$NotificationThreshold,
        [Parameter(Mandatory = $true)]
        [string]$DomainId
    )

    $today = Get-Date
    $allUsers = Get-MgUser -All -Property lastPasswordChangeDateT

    foreach ($user in $allUsers) {
        $passwordExpirationDate = $user.LastPasswordChangeDateTim
```

```
        $daysUntilExpiration = ($passwordExpirationDate - $today)

        if ($daysUntilExpiration -le $NotificationThreshold) {
            Send-PasswordExpirationNotification -User $user -Expi
        }
        else {
            Write-Host "Password is not yet expired. Days until e
        }
    }
}

<#
.SYNOPSIS
   Sends a password expiration notification email to a user.
.DESCRIPTION
   This function sends an email notification to a user whose pass
.PARAMETER User
   The user object for whom the notification is intended.
.PARAMETER ExpirationDate
   The date on which the user's password will expire.
#>
function Send-PasswordExpirationNotification {
    [CmdletBinding()]
    param (
        [Parameter(Mandatory = $true)]
        [PSCustomObject]$User,
        [Parameter(Mandatory = $true)]
        [datetime]$ExpirationDate
    )

    $params = @{
        Message         = @{
            Subject      = "Your Password is About to Expire"
            Body         = @{
                ContentType = 'HTML'
                Content     = "Your password will expire on $Expi
            }
            ToRecipients = @(
                @{
                    EmailAddress = @{
                        Address = $User.mail
                    }
                }
            )
        }
        SaveToSentItems = $true
```

```
    }

    # Send the email using the Graph API
    Send-MgUserMail -UserId $from -BodyParameter $params
}

Connect-MyMgGraph -ClientId 'YOUR_CLIENT_ID' -TenantId 'YOUR_TENA
Check-PasswordExpiration -NotificationThreshold 7 -DomainID "Your
```

WARNING

This exercise was mainly about *how* we'd reorganize things. We haven't tested this extensively, and we've omitted a few things from the original script due to space considerations in the book. If you decide to finish this, do so with our blessing, and please share your results with the original script's author!

17.3 Your turn

Let's get your brain engaged in a "change it to the right way" exercise.

17.3.1 Start here

Consider this example (with apologies for the line-wrapping—it's unavoidable and part of the problem we want to illustrate).

Listing 17.6 Start here

```
foreach ($domain in (Get-ADForest).domains) {
  Get-ADDomainController -filter * -server $domain |
  sort hostname  |
  foreach {
    Get-CimInstance -ClassName Win32_ComputerSystem -ComputerName
    select @{name="DomainController";Expression={$_.PSComputerNam
Manufacturer, Model,@{Name="TotalPhysicalMemory(GB)";Expression={
-f  ($_.TotalPhysicalMemory / 1Gb) }}
    }
}
```

This isn't *bad* code by any stretch. But it's limited. Let's say that one day, you wanted its output on the screen—done! It'll work fine. But tomorrow, you

want the output in a CSV file. Oh, and the day after, your boss wants it in an HTML report. What would you change to enable all of those scenarios?

17.3.2 Your task

Rewrite the code to conform to native PowerShell patterns and practices we've discussed to this point. You don't need to get fancy and add error handling or anything, although you're free to do so if you want.

17.3.3 Our take

Here's how we approached this.

Listing 17.7 Our solution

```
function Get-DiskInfo {
 foreach ($domain in (Get-ADForest).domains) {
   $hosts = Get-ADDomainController -filter * -server $domain |
   Sort-Object -Prop hostname
   ForEach ($host in $hosts) {
    $cs = Get-CimInstance -ClassName Win32_ComputerSystem -Comput
    $props = @{'ComputerName' = $host
               'DomainController' = $host
               'Manufacturer' = $cs.manufacturer
               'Model' = $cs.model
               'TotalPhysicalMemory(GB)'=$cs.totalphysicalmemory
     New-Object -Type PSObject -Prop $props
    } #foreach $host
  } #foreach $domain
} #function
```

Some notes

- We switched to the `ForEach` scripting construct because it tends to run a little faster, and we find it easier to read.
- Rather than using `Select-Object`, we manually constructed an object. We find this easier to read.
- We added both a `DomainController` property and a `ComputerName` property. The original code produced `DomainController`, but we always like to have `ComputerName` because it lines up better in the pipeline with

`-ComputerName` parameters.

- Most important, we encased the code in a function. This makes it easier to pipe the output to `Export-CSV`, `ConvertTo-HTML`, and so on.

Even our solution isn't perfect, because it's still doing two things: getting computer accounts from AD and getting disk information. In a proper production environment, we might write a tool to get domain computer accounts, perhaps based on some criteria. Then we'd modify this function to handle only the disk information. If we planned the properties and parameters right, we could use these hypothetical commands like this:

```
Get-CompanyServers | Get-DiskInfo
Get-CompanyServers | Get-DiskInfo | Convertto-html -title "DiskIn
```

We'll leave it to you to play with this further.

18 Professional-grade scripting

We’re almost ready to call you a *professional* toolmaker in PowerShell. Almost. Before you go around adding “PowerShell Toolmaker” to your resume, we think you should make certain that you’re exhibiting the behaviors and patterns of a true pro. With that in mind, this chapter provides essential guidelines for exhibiting the behaviors and patterns of a true PowerShell pro. Here's a list of best practices to follow if you want to be recognized as a reliable and skilled professional in the PowerShell world.

18.1 Using source control

One hallmark of a professional PowerShell scripter is their commitment to ensuring the longevity and maintainability of their code. Source control, discussed in detail in Chapter 19, plays a pivotal role in achieving these goals. While some might liken source control to the process of filing taxes, the modern tools available have greatly streamlined its usage. Integrated seamlessly with platforms like VS Code, source control is as easy as saving a file and committing changes with a simple keystroke.

Recognize that source control is not just a chore, but a mark of professionalism. Employing source control on your projects offers numerous benefits:

- **Team Collaboration:** In team settings, source control helps prevent conflicts by keeping track of who makes changes, preventing accidental overwrites.
- **Version History:** Revisit previous iterations of your code, either for correcting mistakes or referencing past approaches.
- **Backup and Recovery:** Source control repositories often become part of an organization's backup strategy, ensuring the safety of your codebase.
- **Code Sharing:** Easily share code with others while maintaining control over contributions, essential for community-based projects.

- **Issue Management:** Leading systems like TFS and GitHub provide tools to track issues, discuss problems, and release updates.

Remember, using source control elevates your professional image in the eyes of IT managers and colleagues alike.

18.2 Code Clarity

In the console, shortcuts can save time, but in scripts, readability matters. Avoid using aliases and abbreviated parameter names. We watch PowerShell inventor Jeffrey Snover do demonstrations, and it's all `icm { ps } –com cl2` and stuff, and it looks amazing—and inscrutable. Seriously, someone must stand with him during demos and explain what he typed. pell out command and parameter names fully and embrace tab completion. By doing so, you enhance the readability of your script and minimize typos. Follow this practice right from the start, as it aligns with professional coding.

Again, if it's at the console and it's just for you, fine. Type what you remember, and save time. We all do it. But a script is a permanent artifact, to be shared with others and checked into source control. It needs to be more readable. *Spell out* every command name, *spell out* every parameter name, and *use* parameter names rather than relying on positional values. Your script will be vastly easier for someone else to read—and, as Don often says, in a few months *you'll* be that "someone else," and Future You will appreciate the effort that Past You put into spelling everything out.

It doesn't even need to take much effort. Are you in front of a computer? Look at the Tab key. It's huge, right? Almost the size of the Shift key, and twice the size of any of the letter keys. It's like it *wants* to be pressed. In PowerShell, it's your key to spelling things out with less effort: Use Tab completion. You'll get spelled out *everything*, and you'll reduce your bug count because the computer won't ever typo a command or parameter name. Double win!

Note

We're not the only ones who make a big deal about this point. If you're using

VS Code, you'll be bombarded with red squiggly indicators that something is wrong. That's because the PowerShell extension in VS Code relies on the PSScriptAnalyzer tool, which includes rule-checking for aliases. It probably won't detect if you use a positional parameter, but it will recognize if you use `gsv` instead of `Get-Service`. So write your code the right way from the beginning.

18.3 Effective Comments

Comments are essential for clarity but don't overdo it. Provide high-level explanations for complex sections of your script. Inline comments shouldn't merely restate the obvious. Utilize verbose statements or inline comments effectively to guide readers through your code's logic. Remember, these comments are your way of communicating your thought process to yourself and others. We don't mean this:

```
# Query Win32_ComputerSystem object from WMI
Get-WMIObject –Class Win32_ComputerSystem
```

Gosh, is that what `Get-WmiObject` does? Wow. No, we're not saying you need a line-by-line, blow-by-blow accounting of what your code does. But provide some broad strokes. For example

```
# see if –NewUser was specified and modify arguments
# We use StartPassword either way
If ($PSBoundParameters.ContainsKey('NewUser')) {
  $args = @{'StartName'=$NewUser
            'StartPassword'=$NewPassword}
} Else {
  $args = @{'StartPassword'=$NewPassword}
  Write-Warning "Not setting a new user name"
}
```

Here, we've used a comment to provide a high-level description of what's happening and why. Comments document *what you were thinking* more than anything else, and that's useful to someone else—and again, "someone else" will be *you* a few months from now.

We're also broadly okay with using verbose statements in lieu of some inline comments. For example

```
Write-Verbose "Closing connection to $computer"
$session | Remove-CimSession
```

Removing a CimSession is obvious from the command name, so this doesn't warrant an inline comment. But the verbose statement does help document the progression of the script, and here it does so in a way that the verbose output benefits someone *using* the script as well as someone *reading* the script.

Note

So, um, where are all the inline comments in this book? We've omitted a lot of them because we want to reduce the amount of space we're taking up, and to help you focus on the commands. The examples we use in the book aren't, from a practices-and-patterns perspective, the same code we'd deploy in a production environment.

18.4 Formatting your code

There is *zero* excuse for mangled-looking code. The following listing is unfortunately an all-too-realistic example of what we often see people post in online forums. Given the line-wrapping in this book, you probably can't read it; but look at the downloadable sample code file, and you'll find it just as hard to read.

Listing 18.1 Code that is *not* formatted

```
function Set-TMServiceLogon {
[CmdletBinding()]
Param(
[Parameter(Mandatory=$True,ValueFromPipelineByPropertyName=$True)
[Parameter(Mandatory=$True,ValueFromPipeline=$True,ValueFromPipel
[Parameter(ValueFromPipelineByPropertyName=$True)]
[string]$NewPassword,[Parameter(ValueFromPipelineByPropertyName=$
[string]$NewUser,
[string]$ErrorLogFilePath
)
BEGIN{}
PROCESS{
    ForEach ($computer in $ComputerName) {
```

```
        Do {
     Write-Verbose "Connect to $computer on WS-MAN"
      $protocol = "Wsman"
            Try
{
                $option = New-CimSessionOption -Protocol $protoco
                $session = New-CimSession -SessionOption $option
                If ($PSBoundParameters.ContainsKey('NewUser'))
{
                    $args = @{'StartName'=$NewUser
                              'StartPassword'=$NewPassword}
                }
Else {
                    $args = @{'StartPassword'=$NewPassword}
                    Write-Warning "Not setting a new user name"
                }
                Write-Verbose "Setting $servicename on $computer"
                $params = @{'CimSession'=$session
                  'MethodName'='Change'
        'Query'="SELECT * FROM Win32_Service WHERE Name = '$Servi
               'Arguments'=$args}
                $ret = Invoke-CimMethod @params
                switch ($ret.ReturnValue) {
                  0  { $status = "Success" }
                22 { $status = "Invalid Account" }
                  Default { $status = "Failed: $($ret.ReturnValue
                }
                $props = @{'ComputerName'=$computer;'Status'=$sta
               $obj = New-Object -TypeName PSObject -Property $pr
              Write-Output $obj
                Write-Verbose "Closing connection to $computer"
                 $session | Remove-CimSession
  } Catch {
                # change protocol - if we've tried both
                # and logging was specified, log the computer
                Switch ($protocol) {
                'Wsman' { $protocol = 'Dcom' }
                    'Dcom'  {
                $protocol = 'Stop'
                        if ($PSBoundParameters.ContainsKey('Error
                         Write-Warning "$computer failed; logged
                     $computer | Out-File $ErrorLogFilePath -App
                        }  }
       }
}
        } Until ($protocol -eq 'Stop')
 } }
```

```
END{}
}
```

Go ahead—make sense of that. We dare you. Contrast that to the next listing, which is the same code, doing the same thing.

Listing 18.2 Code that *is* formatted

```
function Set-TMServiceLogon {
    [CmdletBinding()]
    Param(
        [Parameter(Mandatory=$True,
                   ValueFromPipelineByPropertyName=$True)]
        [string]$ServiceName,
        [Parameter(Mandatory=$True,
                   ValueFromPipeline=$True,
                   ValueFromPipelineByPropertyName=$True)]
        [string[]]$ComputerName,
        [Parameter(ValueFromPipelineByPropertyName=$True)]
        [string]$NewPassword,
        [Parameter(ValueFromPipelineByPropertyName=$True)]
        [string]$NewUser,
        [string]$ErrorLogFilePath
    )
BEGIN{}
                                                              #A
PROCESS{
    ForEach ($computer in $ComputerName) {
        Do {
            Write-Verbose "Connect to $computer on WS-MAN"
            $protocol = "Wsman"
            Try {
                $option = New-CimSessionOption -Protocol $protoco
                $session = New-CimSession -SessionOption $option
                If ($PSBoundParameters.ContainsKey('NewUser')) {
                    $args = @{'StartName'= $NewUser
                              'StartPassword' = $NewPassword}
                } Else {
                    $args = @{'StartPassword' = $NewPassword}
                    Write-Warning "Not setting a new user name"
                }
                Write-Verbose "Setting $servicename on $computer"
                $params = @{'CimSession'=$session
                            'MethodName'='Change'
                            'Query'="SELECT * FROM Win32_Service
                            'Arguments'=$args}
```

```
                $ret = Invoke-CimMethod @params
                switch ($ret.ReturnValue) {
                    0  { $status = "Success" }
                    22 { $status = "Invalid Account" }
                    Default { $status = "Failed: $($ret.ReturnVal
                }
                $props = @{'ComputerName'=$computer
                           'Status'=$status}
                $obj = New-Object -TypeName PSObject -Property $p
                Write-Output $obj
                Write-Verbose "Closing connection to $computer"
                $session | Remove-CimSession
            } Catch {
                # change protocol - if we've tried both
                # and logging was specified, log the computer
                Switch ($protocol) {
                    'Wsman' { $protocol = 'Dcom' }
                    'Dcom'  {
                        $protocol = 'Stop'
                        if ($PSBoundParameters.ContainsKey('Error
                            Write-Warning "$computer failed; logg
                            $computer | Out-File $ErrorLogFilePat
                        } # if logging
                     }
                } #switch
            } # try/catch
        } Until ($protocol -eq 'Stop')
    } #foreach
} #PROCESS                         #C
END{}
} #function
```

Outside of this book—where, admittedly, the longer lines still get a little janky, this code is a pleasure to read. You can clearly see where each block of code begins and ends. Look specifically for these things:

- When we close a construct with `}`, we add a comment indicating what it closes.
- We use blank lines to separate chunks of code, so we can see specific functional units more easily.
- We indent four spaces inside each construct.
- Hash tables are constructed with one key-value pair per line, all left-aligned to the same point.

If you’re using VS Code (which, again, we suggest you do), it offers a quick-and-easy reformat option that *will take care of all of this for you!* It even tries to format as you type, to avoid messiness in the first place. That’s the value of a good editor—which in the case of VS Code, costs you zero.

tip

Open the command pallet in VSCode and type `Format Document`. Click this and it will auto-format your document based on best practices. Or even better add this line to your settings.json file to enable autoformat on save.

```
"editor.formatOnSave": true
```

18.5 Meaningful Variable Names

Choose meaningful and descriptive variable names. Avoid Hungarian notation or excessively short variable names. The clarity in variable names enhances code comprehension and maintainability. Yes, sometimes in this book we’ve used `$c` or `$s`, but that’s to save horizontal space on the page. A variable that contains a bunch of disk drive objects should be called something like `$drives` (plural helps remind you that it’s a collection, not a single object). A username should be in `$username`, not `$un`. The only exception is that variables used to declare parameters should follow parameter-naming conventions, which call for singular nouns: `$ComputerName`, not `$ComputerNames`.

Also, avoid the Hungarian notation style of variable naming that came with VBScript *back in the 1990s*. Yes, the 90s. Think about that before you create variables called `$strComputer` and `$intCounter`. Those were needed in VBScript because it was a weakly typed, non-object-oriented language; PowerShell has stronger typing and is object-oriented. A string is an object of the type `System.String`; there’s no need to add *str* to the variable name to remind you of that. Under PowerShell, everything would technically be `$obj` anyway, so Hungarian style is meaningless and makes you look out of touch with current trends.

18.6 Avoiding aliases

While aliases save time in the console, steer clear of them in scripts. Ambiguous aliases can lead to confusion. Instead, use full command names for better readability and understanding. Exceptions are limited to commonly recognized aliases like 'Where' instead of 'Where-Object'. ForEach is less fine, because it’s easy to visually confuse it with ForEach the language construct; use ForEach-Object if you mean to use the command. Particularly avoid hard-to-interpret aliases like `icm` and `gwmi`; spell out the command names, and forget aliases entirely in a script.

18.7 Logic Over Complexity

Maintain logical structure in your scripts. Avoid nesting complex expressions and using awkward pipelines. Your script's goal is to be a structured, permanent artifact, not a one-liner puzzle. Prioritize readability over cleverness. For example

```
Gwmi Win32_operatingsystem | select *,@{n='RAM';e={gwmi
 win32_computersystem | select –exp totalphysicalmemory} | % { $_
 Out-File temp.txt –Append ; $_.Reboot() }
```

Don’t run this unless you’re feeling brave; but look at how difficult it is to read and follow, with its nested expressions, semicolon-delimited commands, and so on. Again—this is *fine* for the command line as an ad hoc, one-off thing. But not for a script.

We don’t automatically avoid all use of the pipeline in a script; after all, it’s one of PowerShell’s more PowerFul features. We’d just go about it differently:

```
$os = Get-WmiObject –Class Win32_OperatingSystem
$cs = Get-WmiObject –Class Win32_ComputerSystem
$os | Add-Member –MemberType NoteProperty –Name RAM –Value `
 $cs.TotalPhysicalMemory
$os | Out-File temp.txt –Append
$os.Reboot()
```

Again, we don’t recommend running that unless you’re brave, but you can see that it’s easier to follow. Each line does one thing, building on the previous lines. And this isn’t the only correct restructure of the original

awkward example; there are a dozen ways you could do this, have it accomplish the same thing in the same amount of time, and be more structured and easier to read. The most clever one-liners in PowerShell are often the hardest to unpack and make sense of—don't subject your scripts to that extra mental overhead.

18.8 Providing help

This is an easy one, and in chapter 14 we showed you a great way to provide a minimally viable product (MVP) when it comes to documenting your code. We get it, documenting is *boring*. Do it anyway. You know how upset you get every time you try to look up the help for a command, and it's either anemic or missing? Yeah. Don't be that coder.

Go one better, and learn how to use PlatyPS, an open source project used by the PowerShell team to generate external (that is, not comment-based) help.

18.9 Avoiding Write-Host and Read-Host

This issue has gotten more confusing as PowerShell has evolved, but the basic maxim still stands: Every time you use `Write-Host` for output, God kills a puppy. The moral is that the `–Host` commands are designed to interact with human eyeballs and fingers. In other words, they tie your command to a specific context—human interaction—which is what tools are supposed to avoid. There are, of course, exceptions.

First, if you're writing a controller script *whose purpose is to engage tools in a human-interactive context*, then obviously the `–Host` commands are fine. They're also fine if you're writing a tool that uses the verb *Show*, which is one of the official PowerShell verbs. That verb—which you might use in a command like Show-Menu—implies human interaction and so again implies a specific context.

Second, in PowerShell v5 and later, `Write-Host` in particular becomes a sort of shortcut to the `Write-Information` channel, which alleviates nearly all the context--tying concerns that used to go along with `Write-Host`. We still don't

think this saves any puppies, though; if you mean to use the Information channel, use `Write-Information`. Using `Write-Host` makes it clear that you don't know `Write-Information` exists and you're using `Write-Host` for all the wrong reasons.

Note

The other counterargument we get all the time is, "But I need `Write-Host` to show the user what's happening!" On one hand, this is a valid concern. If you have a script or tool that requires some processing time or is running through a complex process, it can be useful to provide feedback. But in that case, take the time to learn how to use the `Write-Progress` cmdlet instead of `Write-Host`.

18.10 Sticking with single quotes

In PowerShell, you we prefer single quotes for string delimiters, unless you require variable or subexpression interpolation.

```
$message = "The computer name is $computername"
```

or subexpressions:

```
$message = "Yesterday was $( (Get-Date).AddDays(-1) )"
```

Single quotes provide clarity and prevent unintended variable expansion. If you're not used to using single quotes as string delimiters, this takes some habit-breaking (we can't guarantee that we've followed this rule throughout the book), but it's worth the effort.

18.11 Not polluting the global scope

Do **not** jam your own variables into the global scope. It's a horrible practice, it makes debugging scripts vastly more difficult, and, in several situations, it can result in unreliable and inconsistent script execution (as with a host that manages the global scope differently, such as Workflow). Modules are free to export variables, which will end up in the global scope, but which

PowerShell can manage as part of the module lifecycle. Nothing else should be dumped into the global scope.

18.12 Being flexible

We hope it goes without saying, but we will anyway: Avoid hard-coding values and references. Don't create a function with a hard-coded value for your Exchange server in your code. Instead, create a nonmandatory parameter, and set a default value. This way, you can easily run your function with the default values, but in the rare situation where you need to specify a different server, you'll be able to handle that as well. Don't write a command that looks like this:

```
Function Get-ServerStuff {
$server = ‘SRV01’
...
}
```

Sure, you may think you'll never need to specify a different value, but that might change tomorrow. Pros write tools with flexibility in mind:

```
Function Get-ServerStuff {
Param ([string]$Computername = 'SRV01')
...
}
```

You have to plan not only for how a user might run your tool today but also for how the tool might change in the future.

18.13 Prioritizing secure

Never hard-code credentials into your script. Use `[pscredential]` object as a parameter for secure credential handling. Maintain security while providing flexibility for different usage scenarios.

```
Function Get-Diskspace {
[cmdletbinding()]
Param([string]$Computername,[pscredential]$Credential)
$PSBoundParameters.Add("classname","win32_logicaldisk")
$PSBoundParameters.Add("filter","drivetype=3")
```

```
Get-WmiObject @PSBoundParameters |
Select PSComputername,DeviceID,Size,Freespace
}
```

The user of this function can run it like this:

```
Get-diskspace -computername SRV01 -credential company\administrat
```

in which case they will be prompted for a password. Or pass a `credential` object:

```
$cred = get-credential company\administrator
Get-diskspace -computername SRV01 -credential $cred
```

Writing code that uses the `pscredential` object maintains security and flexibility.

18.14 Striving for elegance

Strive for elegance in your code. Simplify your scripts by avoiding code repetition. Utilize techniques like hash table splatting to create cleaner, more readable code. Over time, aim to develop an elegant coding style. As you develop tools, hopefully following the suggestions in this book, try to achieve a level of simplicity or elegance. We think you'll find that scripts that are elegant are easier to read and debug, and they often perform better. One concept that can help is to avoid repeating code.

Let's say you're creating code that will get system information from WMI using `Get-CimInstance` based on a variable value. Your initial stab might look like this:

```
Switch ($value) {
"OS" {
    $data = Get-Ciminstance -class win32_operatingsystem -compute
}
"CS" {
    $data = Get-Ciminstance -class win32_computersystem -computer
}
"CPU" {
    $data = Get-Ciminstance -class win32_processor -computername
}
```

```
"Memory" {
    $data = Get-Ciminstance -class win32_physicalmemory -computer
}
}
```

This will work fine, but there’s a lot of cumbersome copying, pasting, and editing of code. Contrast that with this example:

```
$cimparams=@{Computername=$Computername}       #A
$props = @('PSComputername')
Switch ($value) {
'OS' {
    $cimparams.Add('classname','win32_operatingsystem')      #B
    $props+='Version','Caption'
}
'CS' {
    $cimparams.Add('classname','win32_computersystem')
    $props+='Model','Manufacturer'
}
'CPU' {
    $cimparams.Add('classname','win32_processor')
    $props+='CPUID','Name','MaxClockSpeed'
}
'Memory' {
    $cimparams.Add('classname','win32_physicalmemory')
    $props+='Banklabel','Capacity','Speed'
}
}
$data = Get-CimInstance @cimparams | Select-object -Property $pro
```

Notice the use of a hash table with parameters for `Get-CimInstance`, which we end up splatting. This is a great technique for simplifying your code. Granted, you need to know about hash tables, splatting, and arrays, but this example feels easier to read and not as heavy-handed.

We provide a lot of techniques in this book. You’ll have to develop them into an art. Elegant code will come to you over time, as you gain experience and mastery. Picasso’s line drawings convey a great deal, with what appears to have been minimal effort, but it took him years to achieve the level of mastery to make that possible. You may be writing your code in crayons today, but eventually we want you to be creating elegant masterpieces.

18.15 Summary

As you progress on your journey to becoming a professional PowerShell scripter, remember that by adopting these professional scripting practices, you'll elevate your PowerShell skills to the next level. These practices not only make your code more reliable and maintainable but also help you establish yourself as a respected professional in the PowerShell community.

19 An introduction to source control with git

One sign of a professional toolmaker is their use of source control. How many of you have a folder on your `C:` that which you keep all of your scripts? Or maybe a network drive at your work that has all of the IT scripts in it? Now that we're in automation and DevOps, properly maintaining our PowerShell projects is critical. For many organizations today, this task falls to *git*, a source control system first made famous on Linux (it was invented by Linux's inventor, Linus Torvalds). We thought it would be helpful to provide a crash course on git fundamentals so that you can begin incorporating it into your work. As you might expect, this is a significant topic, and you'll need to devote time to learning more than the basics. You may want to look at *Learn Git in a Month of Lunches* by Rick Umali (Manning, 2015, www.manning.com/books/learn-git-in-a-month-of-lunches).

19.1 Why source control?

Source control is a means of keeping track of what changes have been made to a file, often including a change log or documentation that indicates who made a change and why. Source control also makes it easier to know which is the latest or more authoritative version. Some systems require you to check out a file to work on it. When you're finished, you can check it in, often with a comment about what you modified and why. While the file is checked out, only you can work with it, which may be fine for smaller teams.

Your organization probably already has a solution in place for the dev team to use for source control. Whether is Microsoft Team Foundation Services (TFS), GitHub, GitLab, or one of the other dozen source control solutions out there. Go ahead and use what the rest of your company is using. The last thing you need is yet another source control program to maintain.

19.2 What is git?

Many traditional source control systems are centralized. Often, there’s a centralized server or database with tightly controlled access. As you can imagine, there’s a fair amount of overhead for these types of systems. Git, on the other hand, was developed as a decentralized source control system. It was developed in the Linux world to help manage source code for the Linux kernel, so it’s pretty robust. In the git paradigm, everyone has their own copies of source files that can be periodically merged and updated.

Git is primarily a command-line tool with only a handful of basic commands you need to get started. As you explore the git ecosystem, you’ll find several graphical front ends and even some PowerShell modules that are essentially wrappers to the git command. We recommend that you stick with the traditional git command-line tools. Once you’ve built up some mainy, feel free to get some GUI tools if that makes you feel better. We also recommend learning from the command line, because there’s a wealth of online information that almost always uses the command line.

Why use git? Mainly because, once you get used to it, it’s dead easy. A ton of tools are available to make it even easier. And, because of the way it’s built, it lends itself very well to highly distributed source control. That means you can keep local copies of files to work on, but keep the main copies on a protected server, on a web-based source control service like GitHub.com, and so on. There are even git tools available for mobile devices running iOS and Android, so you can take your work with you. Perhaps most importantly, git has become massively popular in the PowerShell world, meaning many, many, many community projects—including the source code and documentation for PowerShell Core itself—are hosted in git (specifically, in the web-based GitHub.com service). Becoming familiar with git will not only help you with your own projects but also help you contribute to community projects and PowerShell. If you create your own community projects, hosting them someplace like GitHub will make it easier to recruit other contributors.

19.2.1 Installing git

To get started, go to https://git-scm.com/downloads, and download the latest Windows client. Run the setup; you should be able to accept all the defaults. The setup will create an option to launch git in a Linux-like terminal window,

or you can use the traditional Windows console and PowerShell. That's what we usually use.

19.2.2 Git basics

After the installation is complete, open a PowerShell window. If you had a session open when you installed, you'll need to restart it to detect the change to your path variable. At a prompt, type the `git` command to get general usage help:

```
PS C:\> git
usage: git [--version] [--help] [-C <path>] [-c name=value]
           [--exec-path[=<path>]] [--html-path] [--man-path] [--i
           [-p | --paginate | --no-pager] [--no-replace-objects]
           [--git-dir=<path>] [--work-tree=<path>] [--namespace=<
           <command> [<args>]
...
```

As we go through the basics, we encourage you go to back and look at more detailed command help. Also, run `git help tutorial` to open an HTML documentation page. (You should be able to use your web browser.) On that page, you'll also see a link to a user manual that's definitely worth your time.

For now, we'll be using git as a local source control system with you as the primary user. You'll need to configure a username and email information:

```
git config --global user.email "James@globomantics.com"
git config --global user.name "James Petty"
```

Later, we'll get you started on integrating with GitHub so that you can collaborate with others. If you have GitHub credentials, use them here.

19.3 Repository basics

The first thing you need to do is initialize a git repository. This step essentially tells git to watch this folder. For your scripting projects, this can be the root directory of your module. For git demo purposes, we created a new folder called MyPSTool and changed to it:

```
PS C:\> mkdir MyPSTool
    Directory: C:\
Mode                 LastWriteTime         Length Name
----                 -------------         ------ ----
d-----        6/14/2023   3:20 PM                MyPSTool
PS C:\> cd .\MyPSTool
PS C:\MyPSTool>
```

When you run a git command you need to be in the repository. We tend to run git commands from the root.

19.3.1 Creating a repository

We want this folder to be managed by git, so we initialize it as a repository:

```
PS C:\MyPSTool> git init
Initialized empty Git repository in C:/MyPSTool/.git/
PS C:\MyPSTool> dir -Hidden
    Directory: C:\MyPSTool
Mode                 LastWriteTime         Length Name
----                 -------------         ------ ----
d--h--        6/14/2023   3:26 PM                .git
```

This process creates a hidden directory; we shouldn't ever need to access it or modify anything in it directly. The initialization process also creates the main branch. Later, we'll be able to create additional branches:

```
PS C:\MyPSTool> git status
On branch main
Initial commit
nothing to commit (create/copy files and use "git add" to track)
PS C:\MyPSTool>
```

We'll go ahead and create a few new files and then recheck the status:

```
PS C:\MyPSTool> git status
On branch main
Initial commit
Untracked files:
  (use "git add <file>..." to include in what will be committed)
        file1.ps1
        file2.ps1
nothing added to commit but untracked files present (use "git add
track)
```

Git maintains several virtual areas for tracking your work. As you can see, git is telling us that we have untracked files. This means they aren't part of the source control system. Let's take care of that oversight.

19.3.2 Staging a change

The first step is to *stage* the changes by adding the files. We can either add individual files or stage all of them:

```
PS C:\MyPSTool> git add .
```

Let's check the status now:

```
PS C:\MyPSTool> git status
On branch main
Initial commit
Changes to be committed:
  (use "git rm --cached <file>..." to unstage)
        new file:   file1.ps1
        new file:   file2.ps1
```

The files are staged and ready to be committed to the repository. If we modify a staged file, we'll need to re-add it:

```
PS C:\MyPSTool> git status
On branch main
Initial commit
Changes to be committed:
  (use "git rm --cached <file>..." to unstage)
        new file:   file1.ps1
        new file:   file2.ps1
Changes not staged for commit:
  (use "git add <file>..." to update what will be committed)
  (use "git checkout -- <file>..." to discard changes in working
        modified:   file2.ps1
PS C:\MyPSTool> git add .\file2.ps1
```

Next let's commit the changes.

19.3.3 Committing a change

Committing a change makes it possible to roll back to a given state or undo

changes. If it helps, you can think of your git commits as checkpoints, although they're more than that.

Now we commit the files, including a message comment:

```
PS C:\MyPSTool> git commit -m 'added basic commands'
[main (root-commit) 038b8f9] added basic commands
 2 files changed, 1 insertion(+)
 create mode 100644 file1.ps1
 create mode 100644 file2.ps1
PS C:\MyPSTool>
```

You have to enter a commit message; it can be as long as you need it to be. We've been known to create a here-string:[1]

```
PS C:\MyPSTool> $m=@"
>> this is a sample longer
>> commit message that can
>> cover more than one line.
>> "@
>>
PS C:\MyPSTool> git commit -m $m.
```

We won't notice any changes to files in the directory—everything is tracked in the hidden .git directory. But we can use git's log feature to review what has happened:

```
PS C:\MyPSTool> git log
commit 038b8f9ca8b846e9024532e9bda4e272cd24048b
Author: James Petty <James@globomantics.com>
Date:   Wed Jun 14 16:04:11 2023 -0500
    added basic commands
```

The username makes it easy to detect (or blame someone for) changes made by a specific user.

19.3.4 Rolling back a change

Let's take a quick look at why we're bothering with all this. We created a simple text file and committed it to the repository:

```
PS C:\MyPSTool> set-content -value "don" -Path .\data.txt
```

```
PS C:\MyPSTool> git add .
PS C:\MyPSTool> git commit -m "Added data.txt"
[main 9113535] Added data.txt
 1 file changed, 1 insertion(+)
 create mode 100644 data.txt
PS C:\MyPSTool> git log
commit 9113535942d0c35a964deda9e869a0193bb284ad
Author: James Petty <James@globomantics.com>
Date:   Wed Jun 14 16:12:31 2023 -0500
    Added data.txt
commit 038b8f9ca8b846e9024532e9bda4e272cd24048b
Author: James Petty <James@globomantics.com>
Date:   Wed Jun 14 16:04:11 2023 -0500
    added basic commands
PS C:\MyPSTool>
```

Now we'll modify the data.txt file and commit that change:

```
PS C:\MyPSTool> set-content -value "james" -Path .\data.txt
PS C:\MyPSTool> get-content .\data.txt
james
PS C:\MyPSTool> git commit -a -m "set data.txt to james"
[main ee546b7] set data.txt to james
 1 file changed, 1 insertion(+), 1 deletion(-)
PS C:\MyPSTool>
```

This time, we used a shortcut to commit all pending files with `–a`, skipping the need to run `git -add`.

The log is getting long, so let's just get the last three entries:

```
PS C:\MyPSTool> git log -n 3
commit ee546b73819f1ebbc8b7073c79113e0b6adb5c33
Author: James Petty <James@globomantics.com>
Date:   Wed Jun 14 16:15:48 2023 -0500
    set data.txt to james
commit 9113535942d0c35a964deda9e869a0193bb284ad
Author: James Petty <James@globomantics.com>
Date:   Wed Jun 14 16:12:31 2023 -0500
    Added data.txt
commit 038b8f9ca8b846e9024532e9bda4e272cd24048b
Author: James Petty <James@globomantics.com>
Date:   Wed Jun 14 16:04:11 2023 -0500
    added basic commands
PS C:\MyPSTool>
```

The last entered commit is the problem. In this particular situation, we can reset git like this:

```
PS C:\MyPSTool> git reset --hard head~1
HEAD is now at 9113535 Added data.txt
PS C:\MyPSTool> get-content .\data.txt
don
```

Or suppose some time has passed, and we've made a number of other commits: In our test repo, we've added new files. Then we realize we need to roll everything back to this commit:

```
commit 9113535942d0c35a964deda9e869a0193bb284ad
Author: James Petty <James@globomantics.com>
Date:   Wed Jun 14 16:12:31 2023 -0500
    Added data.txt
```

We can use the reset option again, but this time specify the commit hash number. You don't need the full hash; typically a short hash of the first seven digits will suffice.

Here's what the repo looks like now:

```
PS C:\MyPSTool> dir
    Directory: C:\MyPSTool
Mode                LastWriteTime         Length Name
----                -------------         ------ ----
-a----        6/14/2023   4:49 PM             13 data.txt
-a----        6/14/2023   3:47 PM             48 file1.ps1
-a----        6/14/2023   3:56 PM             66 file2.ps1
-a----        6/14/2023   4:50 PM              0 foo.txt
-a----        6/14/2023   4:46 PM            786 num.txt
PS C:\MyPSTool> get-content .\data.txt
james
jason
```

Next we want to roll back to commit 9113535942d0c35a964deda9e869a0193bb284ad using the short hash value:

```
PS C:\MyPSTool> git reset --hard 9113535
HEAD is now at 9113535 Added data.txt
```

And here's what the repo looks like after the change:

```
PS C:\MyPSTool> get-content .\data.txt
don
PS C:\MyPSTool> dir
    Directory: C:\MyPSTool
Mode                 LastWriteTime         Length Name
----                 -------------         ------ ----
-a----        6/14/2023   5:54 PM               5 data.txt
-a----        6/14/2023   3:47 PM              48 file1.ps1
-a----        6/14/2023   3:56 PM              66 file2.ps1
```

This is a tricky process, and not one you want to undertake all the time, but we wanted to at least demonstrate the value of source control.

There are a number of other types of operations you might need to undo, as well. Check “Git Basics—Undoing Things” at https://git-scm.com/book/id/v2/Git-Basics-Undoing-Things for some helpful guidance.

19.3.5 Branching and merging

One of the benefits of git that can reduce the need to roll back changes is the concept of *branching*. A git branch is a copy of your files, perhaps from a particular commit. You can work on the files all you want without disturbing your main (production) copies. When you’re ready, the changes can be merged into your main branch.

Let’s create a branch called *dev* in the MyPSTool folder:

```
PS C:\MyPSTool> git branch dev
PS C:\MyPSTool> git branch
  dev
* main
```

The asterisk indicates the currently active, or checked out, branch. We’ll switch to the dev branch and add a file using the PowerShell `Set-Content` cmdlet:

```
PS C:\MyPSTool> git checkout dev
git : Switched to branch 'dev'
    + CategoryInfo          : NotSpecified: (Switched to branch '
    + FullyQualifiedErrorId : NativeCommandError
PS C:\MyPSTool> set-content -value '12345' -Path devdata.txt
PS C:\MyPSTool> dir
```

```
    Directory: C:\MyPSTool
Mode                LastWriteTime         Length Name
----                -------------         ------ ----
-a----        6/14/2023   5:54 PM              5 data.txt
-a----        6/14/2023   6:03 PM              7 devdata.txt
-a----        6/14/2023   3:47 PM             48 file1.ps1
-a----        6/14/2023   3:56 PM             66 file2.ps1
```

PowerShell will detect the branch change as an error; we can ignore it. We’ve added a file that we can see in the directory. Let’s add and commit:

```
PS C:\MyPSTool> git add .
PS C:\MyPSTool> git commit -m "added devdata"
[dev 850ca50] added devdata
 1 file changed, 1 insertion(+)
 create mode 100644 devdata.txt
PS C:\MyPSTool> git status
On branch dev
nothing to commit, working tree clean
```

But watch what happens if we change back to the main branch (we omitted the error message):

```
PS C:\MyPSTool> git checkout main
PS C:\MyPSTool> dir
    Directory: C:\MyPSTool
Mode                LastWriteTime         Length Name
----                -------------         ------ ----
-a----        6/14/2023   5:54 PM              5 data.txt
-a----        6/14/2023   3:47 PM             48 file1.ps1
-a----        6/14/2023   3:56 PM             66 file2.ps1
```

The file isn’t there. If we’d made changes to the files we wouldn’t see those either.

We went ahead and switched back to the dev branch and made a few more changes, and then went back to main. We’re curious about the differences between the two branches:

```
PS C:\MyPSTool> git diff dev
diff --git a/data.txt b/data.txt
index f71dff2..910fbb7 100644
--- a/data.txt
+++ b/data.txt
```

```
@@ -1,3 +1 @@
 don
-james
-jason
diff --git a/devdata.txt b/devdata.txt
deleted file mode 100644
index e56e15b..0000000
--- a/devdata.txt
+++ /dev/null
@@ -1 +0,0 @@
-12345
```

Don’t worry if this doesn’t make sense now—checking differences is optional. But now we’ll integrate or *merge* the branches:

```
PS C:\MyPSTool> dir
    Directory: C:\MyPSTool
Mode                 LastWriteTime         Length Name
----                 -------------         ------ ----
-a----        6/14/2023   6:12 PM              5 data.txt
-a----        6/14/2023   3:47 PM             48 file1.ps1
-a----        6/14/2023   3:56 PM             66 file2.ps1
PS C:\MyPSTool> git merge dev
Updating 9113535..b62af84
Fast-forward
 data.txt    | 2 ++
 devdata.txt | 1 +
 2 files changed, 3 insertions(+)
 create mode 100644 devdata.txt
PS C:\MyPSTool> dir
    Directory: C:\MyPSTool
Mode                 LastWriteTime         Length Name
----                 -------------         ------ ----
-a----        6/14/2023   6:17 PM             18 data.txt
-a----        6/14/2023   6:17 PM              7 devdata.txt
-a----        6/14/2023   3:47 PM             48 file1.ps1
-a----        6/14/2023   3:56 PM             66 file2.ps1
```

We included before and after directory listings so you can see the changes.

Using branches is an ideal way to test and develop new code without worrying about messing up your current version. If you decide to scrap the code or are finished with the branch, you can delete it:

```
PS C:\MyPSTool> git branch -d dev
```

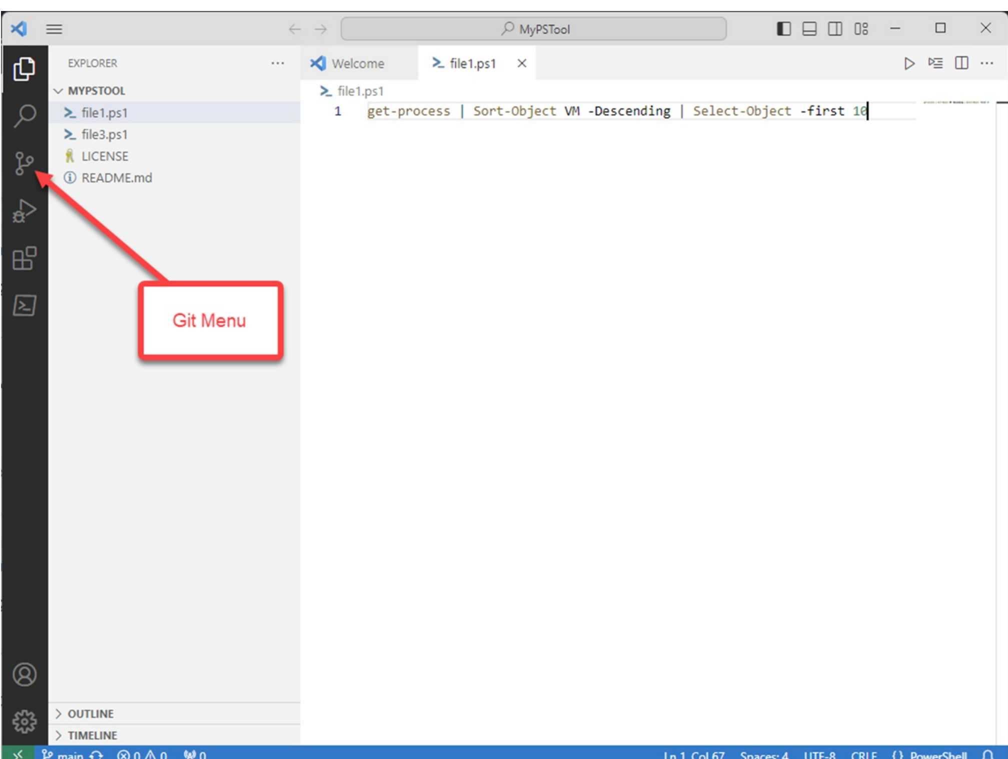
```
Deleted branch dev (was b62af84).
```

19.4 Using git with VS Code

Once you understand the core git concepts such as branches, staging, and committing, you can begin to take advantage of git features in other products, such as Visual Studio Code (VS Code). Git support is integrated into the product, and there are a number of third-party git-related extensions. Of course, you have to have git (v2.0.0 or later) installed on your computer in order for any of this to work.

In VS Code, you can open an entire folder, which is handy when you're developing a module. If the folder is a git repository, VS Code will detect that. Figure 19.1 shows our test folder open in VS Code.

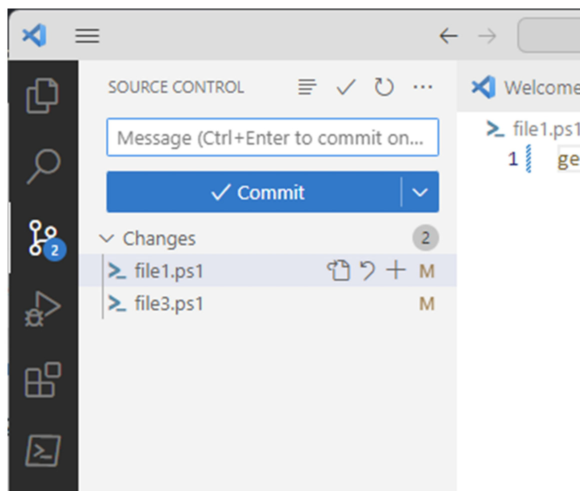
Figure 19.1 Git support in Visual Studio Code



VS Code detected the current branch. There's also an icon to access git-related actions. We'll make some changes to files in the repository in the editor.

When changes are detected, VS Code displays a number over the git icon, indicating the number of files. Click the icon to see the changes, as shown in figure 19.2.

Figure 19.2 Git changes in VS Code



In the console, git shows the changes like this:

```
PS C:\MyPSTool> git status
On branch main
Changes not staged for commit:
  (use "git add <file>..." to update what will be committed)
  (use "git checkout -- <file>..." to discard changes in working
        modified:   file1.ps1
Untracked files:
  (use "git add <file>..." to include in what will be committed)
        file3.ps1
no changes added to commit (use "git add" and/or "git commit -a")
```

But you don’t have to use git from the command line. In VS Code, you can hover the mouse over a file and stage or discard changes on a per-file basis, or you can do the same for all files by hovering over changes. We staged all the changes, as shown in figure 19.3. All that remains is to commit the changes by typing a commit message in the box and clicking the checkmark icon. You can also use the … popup menu to perform other git actions (see figure 19.4).

Figure 19.3 Staged changes in VS Code

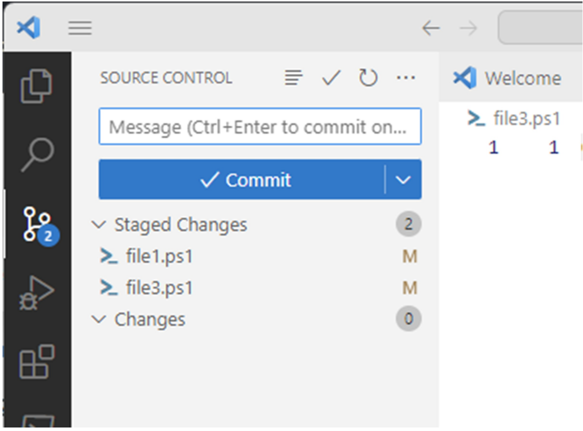
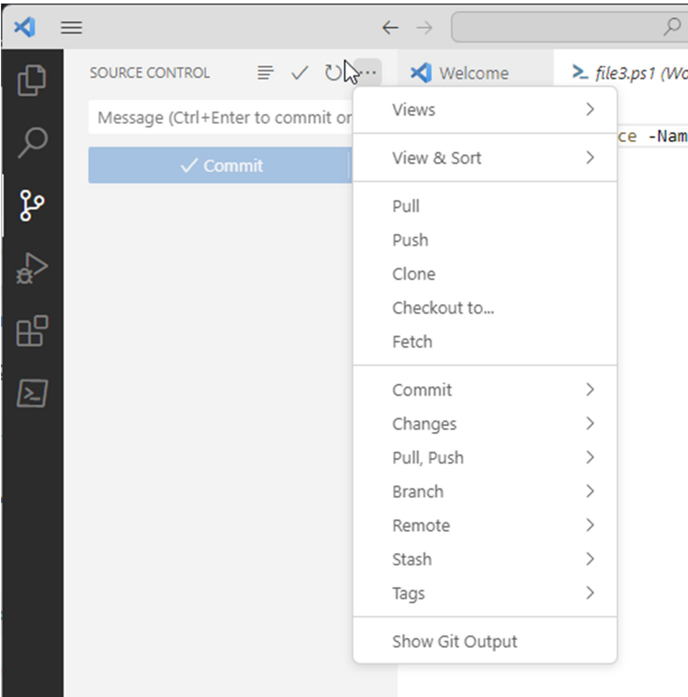


Figure 19.4 Other git options

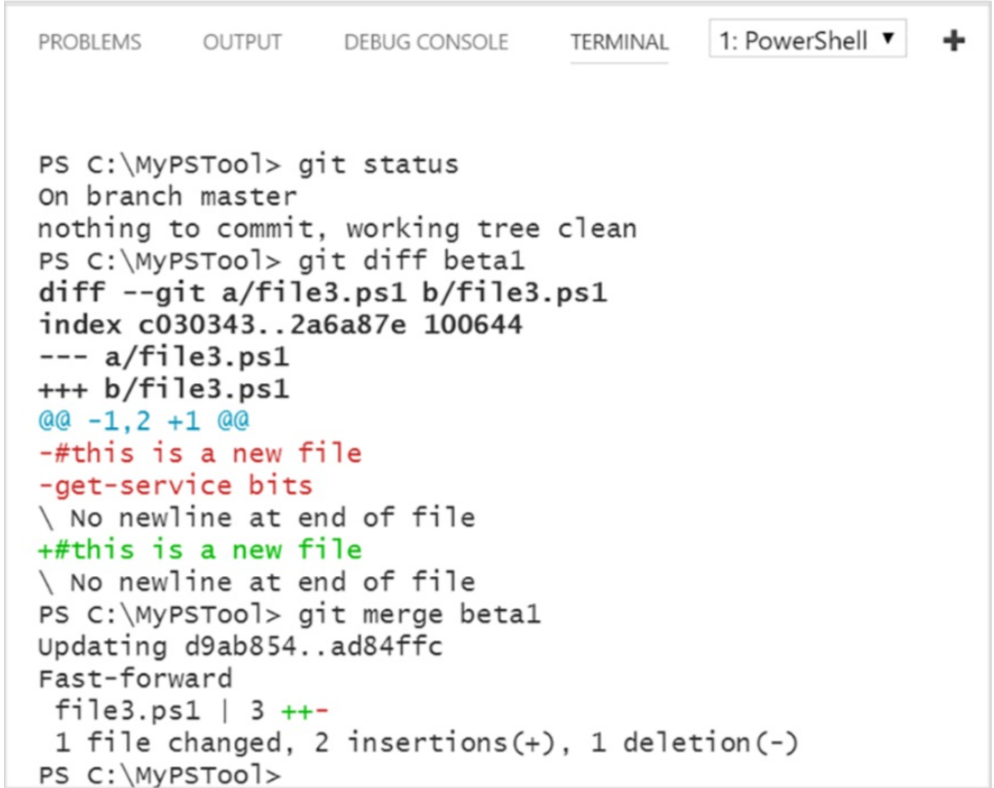


You can even check out or create other branches. Access the command palette by pressing the Ctrl-Shift-P shortcut. In the box, type `git`, and VS Code will auto-populate the drop-down list with available commands. Scroll down to the option to create a new branch, and enter a name for the branch. VS Code will create it and automatically check it out: You can tell because the lower-left corner will indicate the current branch. When you're ready, click the branch name at lower left, and, in the command palette box, click the name of the branch you want to check out.

VS Code makes it easy to see changes, undo changes, and compare changes. We'll let you explore the other git-related icons in the application.

But VS Code is primarily an editor, not a graphical git tool, so some operations require the command line. One example is merging. Yes, you can create a new branch, modify files, and commit them. But there's no way to merge branches in the version of VS Code that's available as we're working on this book. Fortunately, you can use the integrated terminal to run git commands (see figure 19.5).

Figure 19.5 Git commands from the VS Code terminal



Tip

You can discover much more about VS Code and source control integration at https://code.visualstudio.com/docs/editor/versioncontrol.

19.5 Integrating with GitHub

The other cool git-related tool is GitHub. This is a web-based git repository hosting service with its own set of features. Basic access is free, and paid accounts are available for advanced features like private repositories. You technically don't have to have git installed on your computer, but many people do so that they can clone an online repository locally, make changes locally, and push them back to GitHub. This is also how a lot of collaboration is happening today. If you're curious, check out these links:

- https://github.com/psjamesp
- https://github.com/powershellorg
- https://github.com/devops-collective-inc
- https://github.com/powershell

Integrating git with GitHub, especially when you start cloning other repositories and making changes via pull requests, can be confusing and intimidating. But we wanted to give you some basic exposure to how you can use GitHub with your work.

Suppose that, on GitHub, you want to create a copy of the MyPSTool project you've been working with locally. This is a good place to maintain main code while you develop and revise locally. And if other people need to work on the project, they can clone their own copy of the repository to their desktop.

For the sake of simplicity, we're going to use James's GitHub repository (https://github.com/psjamesp), which, as an added benefit, means you can clone the repo and try things yourself. This also means we've modified the username and email in our git configuration to match James's GitHub account. We're assuming that when you sign up for GitHub (which is free, by the way), you'll use the same names as you do locally, or vice versa.

There are two ways to integrate GitHub with a local git project, and which you choose ultimately comes down to where you're starting from. In our case, we already have a local repo that we want to push to GitHub. In GitHub, we'll create a new public repository.

Figure 19.6 Creating a GitHub repository

Create a new repository

A repository contains all project files, including the revision history. Already have a project repository elsewhere?
Import a repository.

Required fields are marked with an asterisk (*).

Owner * psjamesp / Repository name * MyPSTool

MyPSTool is available.

Great repository names are short and memorable. Need inspiration? How about psychic-octo-parakeet ?

Description (optional)

MyPSTool

Public
Anyone on the internet can see this repository. You choose who can commit.

It isn't necessarily required, but we recommend using the same name as your local folder. Feel free to add a description. In this case, you don't need to add a readme file or anything else, because you'll be using an existing local repository.

On the next screen, GitHub provides the code you need, depending on your situation. In our case, we want to push an existing repo from the command line. We'll use these commands from the root of the local folder:

```
PS C:\MyPSTool> git remote add origin https://github.com/psjamesp
PS C:\MyPSTool> git push -u origin main                  #B
Counting objects: 17, done.
Delta compression using up to 2 threads.
Compressing objects: 100% (12/12), done.
Writing objects: 100% (17/17), 1.46 KiB | 0 bytes/s, done.
Total 17 (delta 2), reused 0 (delta 0)
remote: Resolving deltas: 100% (2/2), done.
To https://github.com/psjamesp/MyPSTool.git
 * [new branch]      main -> main
Branch main set up to track remote branch main from origin.
```

You can check the remote configuration like this:

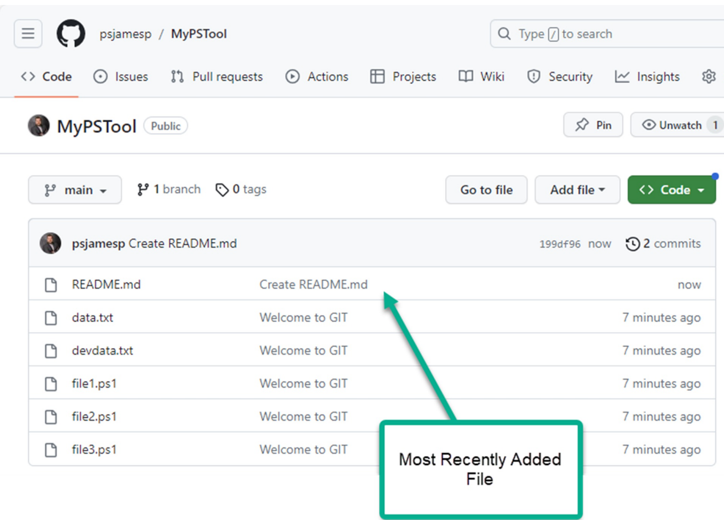
```
PS C:\MyPSTool> git remote
Origin
```

or have more verbose detail:

```
PS C:\MyPSTool> git remote -v
origin  https://github.com/psjamesp/MyPSTool.git (fetch)
origin  https://github.com/psjamesp/MyPSTool.git (push)
```

In GitHub, you can now see the repository with the most current files from the local folder, as shown in figure 19.7.

Figure 19.7 The local repo is now on GitHub.



You could make changes with the editor in GitHub, but we'll assume that you'll make changes locally. Use the local git commands as you normally would, such as committing files:

```
PS C:\MyPSTool> git commit -m 'new changes'
[main 737445d] new changes
 3 files changed, 9 insertions(+), 1 deletion(-)
 create mode 100644 file4.ps1
```

But now, the next time you check the status, git tells you that you aren't in synch with the GitHub repo:

```
PS C:\MyPSTool> git status
On branch main
Your branch is ahead of 'origin/main' by 1 commit.
  (use "git push" to publish your local commits)
nothing to commit, working tree clean
```

It even provides instructions by telling you what to use!

```
PS C:\MyPSTool> git push
Counting objects: 5, done.
Delta compression using up to 2 threads.
Compressing objects: 100% (3/3), done.
Writing objects: 100% (5/5), 600 bytes | 0 bytes/s, done.
Total 5 (delta 0), reused 0 (delta 0)
To https://github.com/psjamesp/MyPSTool.git
   abeeecd..737445d  main -> main
```

If you go back to the browser and refresh, you'll see the changes.

If you or a collaborator modify files in GitHub, you have to manually check and pull those changes down. Running `git status` won't tell you that remote files have changed:

```
PS C:\MyPSTool> git status
On branch main
Your branch is up-to-date with 'origin/main'.
nothing to commit, working tree clean
```

You'll need to fetch and pull:

```
PS C:\MyPSTool> git fetch
remote: Counting objects: 6, done.
remote: Compressing objects: 100% (5/5), done.
remote: Total 6 (delta 2), reused 0 (delta 0), pack-reused 0
Unpacking objects: 100% (6/6), done.
From https://github.com/psjamesp/MyPSTool
   737445d..01f65d7  main     -> origin/main
```

The `fetch` retrieves remote changes. If you just get the prompt, then there are no changes. But if something comes back when you fetch, you need to pull the files from the remote repository:

```
PS C:\MyPSTool> git pull
Updating 737445d..01f65d7
Fast-forward
 data.txt  | 1 -
 file1.ps1 | 2 +-
 2 files changed, 1 insertion(+), 2 deletions(-)
PS C:\MyPSTool>
```

These are the changes we made in GitHub. Once again, the local and remote repositories are in synch.

The other way you can go is to start your project on GitHub first and then clone it locally. Follow the same steps to add a new repository in GitHub; we added one with a readme and license that skips the page with the code commands. Then click Clone Or Download, and copy the link to the clipboard.

In PowerShell, set your location to the parent directory of where you want to create the repo. For our demonstration, we created a GitHub repo for a SharePoint toolset we're planning to build (well, not really). We wanted the local repo to be under C:\scripts, so we made sure we were in that location before running the `git clone` command:

```
PS C:\scripts> git clone https://github.com/psjamesp/sharepointto
Cloning into 'sharepointtools'...
remote: Counting objects: 4, done.
remote: Compressing objects: 100% (3/3), done.
remote: Total 4 (delta 0), reused 0 (delta 0), pack-reused 0
Unpacking objects: 100% (4/4), done.
```

We then changed to the new repo to see the new files:

```
PS C:\scripts> cd .\sharepointtools\
PS C:\scripts\sharepointtools> dir
    Directory: C:\scripts\sharepointtools
Mode                LastWriteTime         Length Name
----                -------------         ------ ----
-a----        6/19/2023   2:59 PM           1088 LICENSE
-a----        6/19/2023   2:59 PM             44 README.md
```

From here on, we used the same steps we showed you.

Try it now

We don't have any exercises for this topic. Using git is something you have to do on your own. We encourage you to install git on your test box. Create a folder, and start playing with the git commands. Experience will be the best teacher. Fortunately, if you run into a problem, a wealth of information and tips are available online.

19.6 Summary

We don’t care what type of source or version control system you use, but we encourage you to use *something*. Git is a good choice because it’s widely used, there’s an incredible amount of online help and references, and it generally seems to be what all the cool kids are using these days. Git is a technology that’s like a foreign language—you won’t gain any proficiency unless you use it all the time.

You don’t have to do anything with GitHub, but it’s a handy collaboration tool, and, if nothing else, a good off-site location. Your company may already have a corporate GitHub account you can use or a private repository server that offers the same functionality.

[1]See “Using Windows PowerShell ‘Here-Strings,’” *TechNet*, http://mng.bz/9r4E.

20 Pestering your script

Pester is a powerful tool for automating your testing in PowerShell scripts. As we transition into a DevOps-oriented world, it becomes crucial to ensure the reliability of your scripts. No one wants a broken script running in a production environment. Even if you test your script initially, modifications or unique conditions might arise that require retesting. This chapter will delve into automated unit testing for PowerShell scripts using Pester.

20.1 The vision

Here’s where we want to get you:

1. You write some code or modify some old code.
2. You check your code into a source control repository.
3. The repository triggers a *continuous integration* pipeline. Usually incorporating third-party tools, the pipeline builds a virtual machine to test your script. The pipeline copies your script into the virtual machine and runs several automated tests. If the tests fail, you get an email telling you what happened.
4. If the tests pass, your code is deployed to a deployment repository (maybe PowerShellGallery.com or a private repo), making it available for production.

Step 3, called "The Miracle," is entirely automated. To enable The Miracle, you must contribute an automated testing mechanism to your code. This way, any code revisions can be quickly retested, ensuring its functionality before deployment.

20.2 Problems with Manual Testing

We’re sure that you’ve manually tested scripts before—possibly even as you wrote scripts for this book. And that’s fine—you should definitely test your code as you go. But there are some problems with manual testing:

- You’re lazy. So are we. You’re not going to run every possible test every time through. And it’ll always be the test you didn’t run that would have caught the error you just made in your code.
- It’s time-consuming. Even if you’re not lazy, manual testing takes time and effort that could be better spent elsewhere.
- It doesn’t tend to learn. It’s not like you have a huge list of tests you know you need to run; you’re probably doing what we do and thinking, “Well, I’ll run it with parameters one time and pipe some stuff to it another time, and that’s probably good.” If you fix a problem, you might test that specific problem right then, but you might or might not retest that specific problem in the future.
- It’s manual. You can’t achieve The Miracle with manual testing. Remember, PowerShell is all about automation—why should testing be excluded from that?

20.3 Benefits of automated testing

Automated testing, on the other hand, rocks—mainly because *it’s automatic* and *learns*. If you run across a weird condition that broke your code once, you add a test for that condition to your test script, and then you’ll never forget to test that weird condition again. Automated tests, therefore, serve as a kind of documented institutional memory. Even if someone *else* modifies your script, and they *don’t know about* that weird condition, the automated test will have their back and make sure the weird condition gets tested.

Automated testing can even move you to a world of test-driven development (TDD). Let’s say you decide to add a new feature to a command. Rather than breaking out and modifying the command’s script, you write a few tests to *test the proposed new feature.* Those tests describe *how you want the new feature to work*, so they serve as a functional specification. The tests will initially fail because you haven’t coded up the new feature yet. But then you start coding the new feature and keep coding until all the tests pass. If you did well on the tests, you’ll know your feature is working correctly.

20.4 Introducing Pester

Pester (*PowerShell Tester*) is an open-source project bundled with Windows 10 and later (newer versions can be found in the PowerShell Gallery). It's an automated unit-testing framework for PowerShell. In other words, you write your tests in Pester, and Pester runs your tests for you. Pester's basic documentation is in the wiki of its GitHub repository at https://github.com/pester/Pester/wiki.

Note

This chapter provides the barest introduction to Pester, intending to whet your appetite. You *need* to read the docs to discover all the other cool things Pester can do that we don't even mention.

As an interesting side note, Microsoft uses Pester to automate the testing of its own PowerShell resources. All kinds of Pester tests are included in the various open-source PowerShell-based components that the PowerShell team has written. These tests number in the thousands! That, if nothing else, should tell you how important and well-regarded Pester is to and by the PowerShell community.

20.5 Coding to be tested

To have a successful relationship with Pester, you must start writing commands and scripts that lend themselves to testing. Follow all the advice we've provided in this book. Specifically, focus on making self-contained, single-task tools. Tools that do eight different things will be hard to test because you will need to test every one of those eight things in all possible combinations and permutations. On the other hand, a tool that does one thing is a lot easier to write tests for.

You must also recognize that Pester is a *PowerShell* testing framework—not COM, not .NET, SQL Server, or anything else. It works best when it only has to deal with PowerShell commands. If you're following our advice—which we'll explore in detail later in this chapter—then you're writing PowerShell commands to wrap any non-PowerShell code you may need to use, meaning at the end of the day, you're *only* dealing with PowerShell commands. In that scenario, you and Pester will get along fine.

20.6 What do you test?

Because this is intended to be a bare-bones introduction to Pester, we're going to fudge a few terms that the automated testing industry takes pretty seriously to put them in a better context with PowerShell. Specifically, we'll use the terms *unit testing* and *integration testing* to lay out a couple of scenarios to help you understand what to write tests for.

20.6.1 Integration tests

An *integration test* tests the *end state* of your command. If you wrote a command to create an SQL Server database, an integration test would run the command and then check to see whether the database existed. In other words, it tests the final impact of your code on the world at large. An integration test treats your code as a black box, meaning it doesn't necessarily know what's happening *inside* the code. It doesn't test to see whether you instantiated the right .NET classes to connect to SQL Server, and it doesn't test whether the username and password you provided work. It just checks the result. You might use an integration test to verify that your toolset accomplishes a specific task under various situations.

Integration tests are a *good thing*. But they're not the *only thing*.

20.6.2 Unit tests

Unit tests are more granular, and they're trickier to imagine. They're not concerned with whether your code *accomplishes* anything—they only want to ensure the code *runs*. For example, you might have a command that can change a service's startup mode and logon password, or it can do just one of those things, depending on which parameters it provides. A unit test will run in all three ways and ensure all the internal logical decisions and code paths run correctly. Whether any particular service is changed or not isn't the concern of the unit test.

Often, you'll write unit tests *and* integration tests. There may be times when you only write unit tests because you're only concerned about your code following the correct paths and logical decisions, and perhaps because *doing*

something—which an integration test would require—would damage or negatively impact your environment. This can be a hard concept for folks to grasp. For example, if you wrote a command that reboots a computer, how could you not check to see whether the computer *rebooted*? Well, it depends. If you were calling a command like `Restart-Computer`, you *wouldn't need to test that*—you'd want to test *your* code that *led up to* `Restart-Computer` being called, which brings us to our next point.

20.6.3 Don't test what isn't yours

Particularly with unit tests, your goal is to test *your code*. The `Restart-Computer` command *isn't your code*. It's Microsoft's code. If Microsoft's code is broken, that isn't your problem. Your unit test is there to ensure the code you can control works correctly. Let's take that exact scenario and turn it into a Pester example.

20.7 Writing a basic Pester test

Let's start with the command shown in the following listing. It's deliberately simplistic so that we can focus on the unit-testing aspect. The command will allow you to either restart or shut down a computer.

Listing 20.1 A command to test

```
function Set-ComputerState {
    [CmdletBinding()]
    Param(
        [Parameter(Mandatory=$True,
                   ValueFromPipeline=$True,
                   ValueFromPipelineByPropertyName=$True)]
        [string[]]$ComputerName,
        [Parameter(Mandatory=$True)]
        [ValidateSet('Restart','Shutdown')]
        [string]$Action,
        [switch]$Force
    )
    BEGIN {}
    PROCESS {
        ForEach ($comp in $ComputerName) {
            $params = @{'Computername' = $comp}
```

```
            # force?
            if ($force) {
                $params.Add('Force',$true)
            }
            # which action?
            If ($Action -eq 'Restart') {
                Write-Verbose "Restarting $comp (Force: $force)"
                Restart-Computer @params
            } else {
                Write-Verbose "Stopping $comp (Force: $force)"
                Stop-Computer @params
            }
        }
    } #PROCESS
    END {}
}
```

READ IT NOW

Take some time to read through this command and develop an expectation for what it does and how it works. You may think of other, and even better, ways to accomplish its task. We've gone this route to help illustrate Pester testing well.

When it comes to unit testing, we know right away two things we will not be testing: whether Restart-Computer or `Stop-Computer` work. "But wait!" you might cry. "Those are the only two things that are *doing* anything!" Correct—and if we were writing an integration test, that would matter. Unit tests don't care about the result; they care about whether *our code runs correctly*. We won't unit test them because those two commands aren't our code.

Inside or outside?

Another way to think about unit and integration tests is like this: *How much of your code does the test know about?*

With an integration test, your code is a black box, as we suggested earlier. The test doesn't know how you accomplished a restart or a shutdown; it only cares whether it occurred. The integration test *doesn't know anything* about the contents of your command; it isn't going to try to make sure every possible code path is tested, every possible parameter is used, and so on.

With a unit test, your code is an open book. The test doesn't care about the result of running your code—it only cares about whether *all* of your code ran. Was every parameter used in some way? Did every code path execute? Was every logical decision run in every possible combination? It's about the *code*, not the *result*.

Again, both kinds of tests are essential, but we're focused on unit tests for now.

20.7.1 Creating a fixture

We'll start by loading the Pester module and asking it to create a new test fixture for us:

```
PS C:> Import-Module Pester
PS C:> Mkdir example
PS C:> New-Fixture –Path example –Name Set-ComputerState
```

Installing and updating Pester

We're assuming that the Pester module is available on your system; on Windows 10 or later, it will be by default. If you don't have the module, install it first from the PowerShell Gallery by running `Install-Module Pester`.

If you're running Windows 10 or later, the shipping version of the Pester module is outdated. Unfortunately, updating the module from the PowerShell Gallery is problematic. You can't uninstall the shipping version (at least, not easily), and you may have problems getting the latest version. See the blog post "Power-Shell PackageManagement and PowerShellGet Module Changes in Windows 10 Version 1511, 1607, and 1703" from Microsoft MVP Mike Robbins (August 3, 2017, http://mng.bz/40c7) for more details. As a last resort, you should be able to install the latest version of the Pester module and have it run side by side with the shipping version with this command:

```
Install-module pester -Repository psgallery -force –SkipPublisher
```

This new *fixture* is a couple of blank files: one for our code (Set-ComputerState.ps1) and one for our tests (Set-ComputerState.Tests.ps1).

Think of the fixture as a skeleton. We’ll open both in VS Code. We’ll paste our function into Set-ComputerState.ps1 as a starting point, replacing the empty Set-ComputerState function already there.

TRY IT NOW

Please do follow along with us, set up your fixture, and paste listing 20.1 into the code script.

The test script—which you should create on your own by running the previous commands, so we won’t provide a copy as a downloadable sample —should look like this:

```
$here = Split-Path -Parent $MyInvocation.MyCommand.Path
$sut = (Split-Path -Leaf $MyInvocation.MyCommand.Path) -replace '
. "$here\$sut"
Describe "Set-ComputerState" {
    It "does something useful" {
        $true | Should Be $false
    }
}
```

Aside from the first three commands at the top, which link this test code to the code script, there are two sections:

- The `Describe` block is designed to contain a set of tests. These all execute within the same scope. Scoping in Pester is both complex and powerful, and as you get into more complex tests, you’ll often define multiple `Describe` blocks. For now, we’ll stick with this one.
- The `It` block represents a single test, which our code will either pass or fail. A `Describe` block often contains many `It` blocks, each testing a specific, discrete condition.

20.7.2 Writing the First Test

Let’s modify the provided `It` block to test something:

```
Describe "Set-ComputerState" {
    It "accepts one computer name" {
        Set-ComputerState –computername SERVER1 –Action restart |
```

```
        Should Be $true
    }
}
```

This is the basic model for an `It` block: You run something and then tell Pester what the result should have been. However, what we've written here won't work because our `Set-ComputerState` function never outputs anything to the pipeline. Therefore, it isn't piping anything to `Should`, so it `Should` not look at a `$true` value as we've implied. This brings us to a heck of a problem —when we have a function that doesn't produce any output, and we're not attempting to test if it does anything, how do we test the dang thing?

Our dilemma, stated more specifically, is that *we need to see how many times* `Restart-Computer` *is called without calling* `Restart-Computer`. Tricky. And the answer to that trick is a key element of Pester: the mock.

20.7.3 Creating a mock

In testing, you'll often want to have some commands that *seem* to run but not run. For example, you might need `Import-CSV` to import a specific CSV file, but you don't want to create the file. Or, in our case, we want `Restart-Computer` to *seem* to run so we can figure out if our code tried to run it, but we do not want to restart a computer. This is where Pester's mocking comes into play. It creates a fake replacement for an existing command, and that fake can do whatever you like:

```
Describe "Set-ComputerState" {
    Mock Restart-Computer { return 1 }
    Mock Stop-Computer { return 1 }
    It "accepts one computer name" {
        Set-ComputerState -computername SERVER1 -Action Restart |
        Should Be 1
    }
}
```

Our fake version of `Restart-Computer` will now output 1. It won't restart any computers—it'll just output 1. And so if it's called once, the result of `Set-ComputerState` should be 1. We've told Pester as much with our `It` block. Let's try running this simple test to see whether it works. From our example folder, which contains our test script, we have to run `Invoke-Pester`:

```
Describing Set-ComputerState
 [+] accepts one computer name 678ms
Tests completed in 678ms
Passed: 1 Failed: 0 Skipped: 0 Pending: 0 Inconclusive: 0
```

TRY IT NOW

The results are better in full color, so see if you can get similar output by copying what we’ve done so far.

The `[+]` tells us that our single test passed.

20.7.4 Adding more tests

Let’s add a few more tests:

```
Describe "Set-ComputerState" {
    Mock Restart-Computer { return 1 }
    Mock Stop-Computer { return 1 }
    It "accepts and restarts one computer name" {
        Set-ComputerState -computername SERVER1 -Action Restart |
        Should Be 1
    }
    It "accepts and restarts many names" {
        $names = @('SERVER1','SERVER2','SERVER3')
        $result = Set-ComputerState -computername $names -Action
        $result.Count | Should Be 3                   #B
    }
    It "accepts and restarts from the pipeline" {
        $names = @('SERVER1','SERVER2','SERVER3')
        $result = $names | Set-ComputerState -Action Restart
        $result.count | Should Be 3
    }
}
```

We took a different approach on the second two tests. Remember, each time our mocked `Restart-Computer` runs; it outputs 1. That means running it three times doesn’t output 3; it outputs three 1s. We capture that collection of integers into `$result`. Then, on a new line, we pipe `$result. Count` to `Should`, checking whether the array contains three items. This tells us that our mocked command was called three times. Here are the results:

```
Describing Set-ComputerState
```

```
 [+] accepts and restarts one computer named 252ms
 [+] accepts and restarts many names 374ms
 [+] accepts and restarts from the pipeline 332ms
Tests completed in 959ms
Passed: 3 Failed: 0 Skipped: 0 Pending: 0 Inconclusive: 0
```

Perfect! But there’s a slightly better way to construct these tests. When you mock a command in Pester, behind the scenes, it automatically tracks how many times the mock was used. Because our only goal is to count the number of times our fake command was run, we could let Pester do all the work for us. We’ll do this by using the `Assert-MockCalled` command:

```
Describe "Set-ComputerState" {
    Mock Restart-Computer { return 1 }
    Mock Stop-Computer { return 1 }
    It "accepts and restarts one computer name" {
        Set-ComputerState -computername SERVER1 -Action Restart
        Assert-MockCalled Restart-Computer -Exactly 1
    }
    It "accepts and restarts many names" {
        $names = @('SERVER1','SERVER2','SERVER3')
        Set-ComputerState -computername $names -Action Restart
        Assert-MockCalled Restart-Computer -Exactly 3
    }
    It "accepts and restarts from the pipeline" {
        $names = @('SERVER1','SERVER2','SERVER3')
        $names | Set-ComputerState -Action Restart
        Assert-MockCalled Restart-Computer -Exactly 3
    }
}
```

Let’s try it:

```
Describing Set-ComputerState
 [+] accepts and restarts one computer named 740ms
 [-] accepts and restarts many names 144ms
   Expected Restart-Computer to be called 3 times exactly but was
times
   18:         Assert-MockCalled Restart-Computer -Exactly 3
   at <ScriptBlock>, \\vmware-host\Shared Folders\Documents\examp
ComputerState.Tests.ps1: line 18
 [-] accepts and restarts from the pipeline 409ms
   Expected Restart-Computer to be called 3 times exactly but was
times
   24:         Assert-MockCalled Restart-Computer -Exactly 3
```

```
   at <ScriptBlock>, \\vmware-host\Shared Folders\Documents\examp
ComputerState.Tests.ps1: line 24
Tests completed in 1.29s
Passed: 1 Failed: 2 Skipped: 0 Pending: 0 Inconclusive: 0
```

That's not good. Looking at the failure output, it appears as if the counter doesn't reset for each `It` block by default. We have to modify the command, so it knows we want to count for each `It` block rather than adding up everything that happened in the parent. `Describe` block:

```
Describe "Set-ComputerState" {
    Mock Restart-Computer { return 1 }
    Mock Stop-Computer { return 1 }
    It "accepts and restarts one computer name" {
        Set-ComputerState -computername SERVER1 -Action Restart
        Assert-MockCalled Restart-Computer -Exactly 1 -Scope It
    }
    It "accepts and restarts many names" {
        $names = @('SERVER1','SERVER2','SERVER3')
        Set-ComputerState -computername $names -Action Restart
        Assert-MockCalled Restart-Computer -Exactly 3 -Scope It
    }
    It "accepts and restarts from the pipeline" {
        $names = @('SERVER1','SERVER2','SERVER3')
        $names | Set-ComputerState -Action Restart
        Assert-MockCalled Restart-Computer -Exactly 3 -Scope It
    }
}
```

And now, let's try it:

```
Describing Set-ComputerState
 [+] accepts and restarts one computer name 430ms
 [+] accepts and restarts many names 335ms
 [+] accepts and restarts from the pipeline 283ms
Tests completed in 1.05s
Passed: 3 Failed: 0 Skipped: 0 Pending: 0 Inconclusive: 0
```

That's exactly what we were looking for.

20.7.5 Code coverage

If one of the goals of unit testing is to ensure all of your code runs, then you need to know whether you've hit that goal. Pester can help. Running `Invoke-`

`Pester -Code-Coverage ./Set-ComputerState.ps1` will generate a *code-coverage report* for that script, like this one:

```
Describing Set-ComputerState
 [+] accepts and restarts one computer name 1.64s
 [+] accepts and restarts many names 68ms
 [+] accepts and restarts from the pipeline 1.55s
Tests completed in 3.26s
Passed: 3 Failed: 0 Skipped: 0 Pending: 0 Inconclusive: 0
Code coverage report:
Covered 70.00 % of 10 analyzed commands in 1 file.
Missed commands:
File                  Function          Line Command
----                  --------          ---- -------
Set-ComputerState.ps1 Set-ComputerState   24 $params.Add('Force',
Set-ComputerState.ps1 Set-ComputerState   32 Write-Verbose "Stopp
(Force: $force)"
Set-ComputerState.ps1 Set-ComputerState   33 Stop-Computer @param
```

This helps you understand what's missing. Getting 100% code coverage means *every line of code ran*; it doesn't necessarily mean you're finished testing, because sometimes you need to test different variations with that same code. But code coverage does help you spot code paths you may have missed. In our case, we can see that we've never run the code that accounts for our `–Force` parameter, and we've never run a test where we try to stop a computer, rather than restart it. Let's add some more tests:

```
Describe "Set-ComputerState" {
    Mock Restart-Computer { return 1 }
    Mock Stop-Computer { return 1 }
    It "accepts and restarts one computer name" {
        Set-ComputerState -computername SERVER1 -Action Restart
        Assert-MockCalled Restart-Computer -Exactly 1 -Scope It
    }
    It "accepts and restarts many names" {
        $names = @('SERVER1','SERVER2','SERVER3')
        Set-ComputerState -computername $names -Action Restart
        Assert-MockCalled Restart-Computer -Exactly 3 -Scope It
    }
    It "accepts and restarts from the pipeline" {
        $names = @('SERVER1','SERVER2','SERVER3')
        $names | Set-ComputerState -Action Restart
        Assert-MockCalled Restart-Computer -Exactly 3 -Scope It
    }
    It "accepts and force-restarts one computer name" {
```

```
        Set-ComputerState -computername SERVER1 -Action Restart -
        Assert-MockCalled Restart-Computer -Exactly 1 -Scope It
    }
    It "accepts and shuts down one computer name" {
        Set-ComputerState -computername SERVER1 -Action Shutdown
        Assert-MockCalled Stop-Computer -Exactly 1 -Scope It
    }
}
```

And let’s run that:

```
Describing Set-ComputerState
 [+] accepts and restarts one computer name 552ms
 [+] accepts and restarts many names 64ms
 [+] accepts and restarts from the pipeline 86ms
 [+] accepts and force-restarts one computer name 277ms
 [+] accepts and shuts down one computer name 115ms
Tests completed in 1.1s
Passed: 5 Failed: 0 Skipped: 0 Pending: 0 Inconclusive: 0
Code coverage report:
Covered 100.00 % of 10 analyzed commands in 1 file.
```

We now have more confidence that we’re testing all our code paths and that our code is responding how we want it to.

20.8 Summary

To close out this chapter, the following listing includes our completed test script, for your reference.

Listing 20.2 Completed Pester test

```
$here = Split-Path -Parent $MyInvocation.MyCommand.Path
$sut = (Split-Path -Leaf $MyInvocation.MyCommand.Path) -replace '
. "$here\$sut"
Describe "Set-ComputerState" {
    Mock Restart-Computer { return 1 }
    Mock Stop-Computer { return 1 }
    It "accepts and restarts one computer name" {
        Set-ComputerState -computername SERVER1 -Action Restart
        Assert-MockCalled Restart-Computer -Exactly 1 -Scope It
    }
    It "accepts and restarts many names" {
        $names = @('SERVER1','SERVER2','SERVER3')
```

```
        Set-ComputerState -computername $names -Action Restart
        Assert-MockCalled Restart-Computer -Exactly 3 -Scope It
    }
    It "accepts and restarts from the pipeline" {
        $names = @('SERVER1','SERVER2','SERVER3')
        $names | Set-ComputerState -Action Restart
        Assert-MockCalled Restart-Computer -Exactly 3 -Scope It
    }
    It "accepts and force-restarts one computer name" {
        Set-ComputerState -computername SERVER1 -Action Restart -
        Assert-MockCalled Restart-Computer -Exactly 1 -Scope It
    }
    It "accepts and shuts down one computer name" {
        Set-ComputerState -computername SERVER1 -Action Shutdown
        Assert-MockCalled Stop-Computer -Exactly 1 -Scope It
    }
}
```

Of course, this may not be a *complete* test. We haven’t added any integration tests, for example, and we haven’t tested to ensure that only values like `Restart` and `Shutdown` are accepted for the `–Action` parameter. This test could certainly grow to be more complex—and we invite you to expand it to further explore how Pester can help automate your testing. You can jump on all this by reading the help topic `about_pester`.

21 Signing your script

In the world of highly effective PowerShell toolmakers, script signing is a habit that cannot be overlooked. While some might find it daunting or unnecessary, we firmly believe in its importance, which is why this chapter exists. Whether you anticipate your scripts staying within your organization or not, script signing, coupled with source control, should be a part of your toolkit.

21.1 The Significance of Script Signing

Why should you invest your time and effort in script signing? At its core, a signed script serves two crucial purposes. Firstly, it authenticates the identity of the script's author. Now, this doesn't necessarily guarantee the script's safety or quality, but if the script is signed, you can at least trace it back to its creator. Secondly, signing ensures script integrity, meaning it verifies if the code has been tampered with since it was signed. Protecting your code is paramount, especially when it leaves the confines of your organization. Let's say you receive a script from Sally or download one from a blog. How confident are you that every line of code is precisely as Sally intended? If she has signed the file, you can be certain that every character is a true reflection of Sally’s work. Should any malicious code be discovered, you can hold Sally accountable.

Internally, accidental modifications can happen. An innocent intern or an unwitting boss might inadvertently alter your script. Without code signing, you may only realize something is amiss when your script produces less-than-optimal results. With signed scripts, PowerShell acts as your guardian, instantly notifying you of any issues, and allowing you to investigate promptly. PowerShell lives up to its name as a powerful tool. A small piece of code can wreak havoc. Protect your code, and in turn, yourself, by embracing script signing.

21.2 A word about certificates

Before delving into script signing, you'll need a certificate. Certificates play a vital role in identity verification, acting as digital ID cards. Commercial certificate authorities (CAs) are responsible for certifying identities, embedding the certificate holder's identity within the certificate itself. Certificates revolve around trust. If you trust the CA, you can trust the certificate it issues.

Code signing is a significant responsibility for CAs because code has the potential to cause considerable harm. Obtaining a Class 3 code-signing certificate from a commercial CA typically requires rigorous identity verification processes and is often granted to organizations rather than individuals. However, organizations can set up their internal public key infrastructure (PKI), running their own CA and establishing the rules for certificate issuance. If your code stays within your organization, this is a cost-effective alternative to purchasing a commercial code-signing certificate.

In cases where you are the sole user and maintainer of your code on your personal computer, you can create a self-signed certificate. While convenient for development, self-signed certificates should be replaced with real certificates when deploying code to others, even within your organization.

Certificates, trust, and Necessary Effort

It's no secret that managing certificates can be a hassle. They expire, necessitating renewal, and setting up an internal PKI is a complex task. However, as IT professionals, this is part of our core competency, and we must be proficient in managing this aspect of security.

The traditional CA model faces competition from innovative approaches like notarization, which allows the creation of self-signed certificates with the oversight of trusted individuals. While beyond the scope of this chapter, it's worth exploring this decentralized trust system as an alternative to centralized CA trust models.

Once you have a certificate, you can install it and begin using it—which we’ll cover briefly. Because this isn’t a chapter on PKI, we’ll refresh your memory that certificates consist of *key pairs*. In particular, yours will have a *private key* that you should keep incredibly safe and secure, even password-

protecting it within the Windows certificate store, so that it can't be used without your permission. The private key is used to generate script *signatures*. A signature is basically a copy of your script (or, more commonly, a hash, which is still unique to the script but takes up less room), encrypted using the private key, and bundled along with information about your certificate (but not the private key).

Anyone else who trusts the source of your certificate can then decrypt that signature, using the *public key* side of the key pair. Their ability to decrypt it, using your public key, means they can confirm your identity, because only your closely held private key could have encrypted the script in the first place. They can then compare the previously encrypted script to the clear-text version; if the two match, then they know the code is exactly as you wanted it to be.

21.3 Configure Your Script Signing Policy

To make script signing effective, you need to configure your environment to require signed scripts. Signing a script alone is insufficient if PowerShell is not instructed to enforce this requirement. In an elevated PowerShell session, execute the following command:

```
Set-Executionpolicy AllSigned -force
```

The `–Force` parameter will suppress the confirmation prompt. You only must do this once on any machine where you'll be running scripts. Presumably, this is your desktop or a centralized management server. It would be best if you rarely had to run an interactive script on a remote server, so you can leave those execution policies set to Restricted, which is the default.

Even if you use `Invoke-Command` to run a local script on a remote server, PowerShell is running the *contents* of the hand remotely. You should probably verify the script locally before running it remotely. We'll show you that in a few minutes.

You can also use Group Policy to configure script-execution policies if you're in an Active Directory domain. Note that these policies aren't security

boundaries but rather are like the covers on launch switches for nuclear missiles. We covered all of this in much greater detail in chapter 7.

21.4 Code-signing Basics

Delving into the basics of certificates and PKI is beyond the scope of this chapter, but here's a simplified explanation. A certificate is a cryptographic means of verifying your identity. When you sign a script in PowerShell, your certificate's identity information is included in the script's signature block, confirming you as the script's author. Additionally, PowerShell computes a hash value based on the script's content and embeds it in the script's signature. If any modification, no matter how minor, is made to the file, the signature breaks and PowerShell reports the script as changed.

21.4.1 Acquiring a Code-Signing Certificate

Not all certificates can be used for script signing; they must be Class 3 code-signing certificates that support Microsoft's Authenticode extension.

NOTE

Class 3 is a term that VeriSign used back in the day; it’s rare to see it now. Most people just call them code-signing certificates.

The certificate must also be issued by a CA trusted by your computer. Suppose you intend to distribute signed tools outside of your organization. In that case, you’ll most likely need a certificate from a third-party vendor like VeriSign or DigiCert because anyone who downloads your code will trust them to have issued your certificate. But we expect that most of you have an AD domain, ideally with a certificate infrastructure (Active Directory Certificate Services [AD CS]). With this, you can quickly go through the web-based interface to request a code-signing certificate under your organization’s policies. You can then configure Group Policy so that domain members will trust your certificate (this will usually be in place if the PKI was set up correctly). The details are beyond the scope of this book, but if you get stuck, we’re confident the residents of the forums at PowerShell.org can help.

Note

To summarize, step 1 is to find a CA—either commercial or external. Remember that code-signing certs aren't cheap, and a cheap one wouldn't be worth the digital ink it's made of. Certificates are usually issued only to organizations like companies, not to individuals, and when obtained commercially, they typically have a reasonably extensive identity verification process.

Another option for testing purposes, or if you intend that your PowerShell scripts and tools will never leave your desktop, is to use a self-signed certificate. In years past, this meant mastering the arcane command-line utility makecert.exe. But the PowerShell PKI module, which you should get when you install the Remote Server Administration Tools, includes a command that makes this easier. If you want to try out code signing, run a command like this:

```
PS C:\> New-SelfSignedCertificate -type CodeSigningCert -Subject
   PSParentPath: Microsoft.PowerShell.Security\Certificate::Curre
Thumbprint                                  Subject
----------                                  -------
9D16AF2573AC6C01A33752CA5135F3700A6FE9CFCN=Art Deco
```

Naturally, insert your own name in the `CN=` part. Because this is a self-signed certificate, include the `-TestRoot` parameter. You'll still get a certificate you can use, but PowerShell will give you an "unknown error" message because it can't verify the certificate chain. That is, your computer doesn't *trust itself* as a source of certificates.

We've told PowerShell to store the certificate for the current user. This is easy enough to verify with the `-codesigningcert` parameter on `Get-ChildItem`. We'll use the `dir` alias:

```
PS C:\> dir Cert:\CurrentUser\My\ -CodeSigningCert
   PSParentPath: Microsoft.PowerShell.Security\Certificate::Curre
Thumbprint                                  Subject
----------                                  -------
9D16AF2573AC6C01A33752CA5135F3700A6FE9CFCN=Art Deco
```

You can have multiple code-signing certificates installed, but you can only

sign with a single one. If you have multiple certs installed, you’ll need to be able to use PowerShell and filter for the exact one.

TIP

In the certificate world, a certificate’s *thumbprint* is its official, unique name. You’ll see many references to it, and now you know how to find it.

21.4.2 Trusting self-signed certificates

Before you can use a self-signed cert, you may need to take a few additional steps outside of PowerShell. At a prompt, run this command to open the certificate management snap-in:

```
Certmgr.msc
```

Navigate to where you stored the certificate, as shown in figure 21.1. You’ll see that it’s issued by CertReq Test Root. The problem you’ll run into is that the certificate for this root isn’t completely trusted. Why would it be? Again, you can’t use your crayon-made, self-signed driver’s license, because nobody but you trusts it; it’s the same situation with a self-signed certificate. You can install that root certificate by dragging and dropping it from the Intermediate Certification Authority container to Trusted Root Certification Authority, as indicated in figure 21.2.

Figure 21.1 Selecting the self-signed certificate

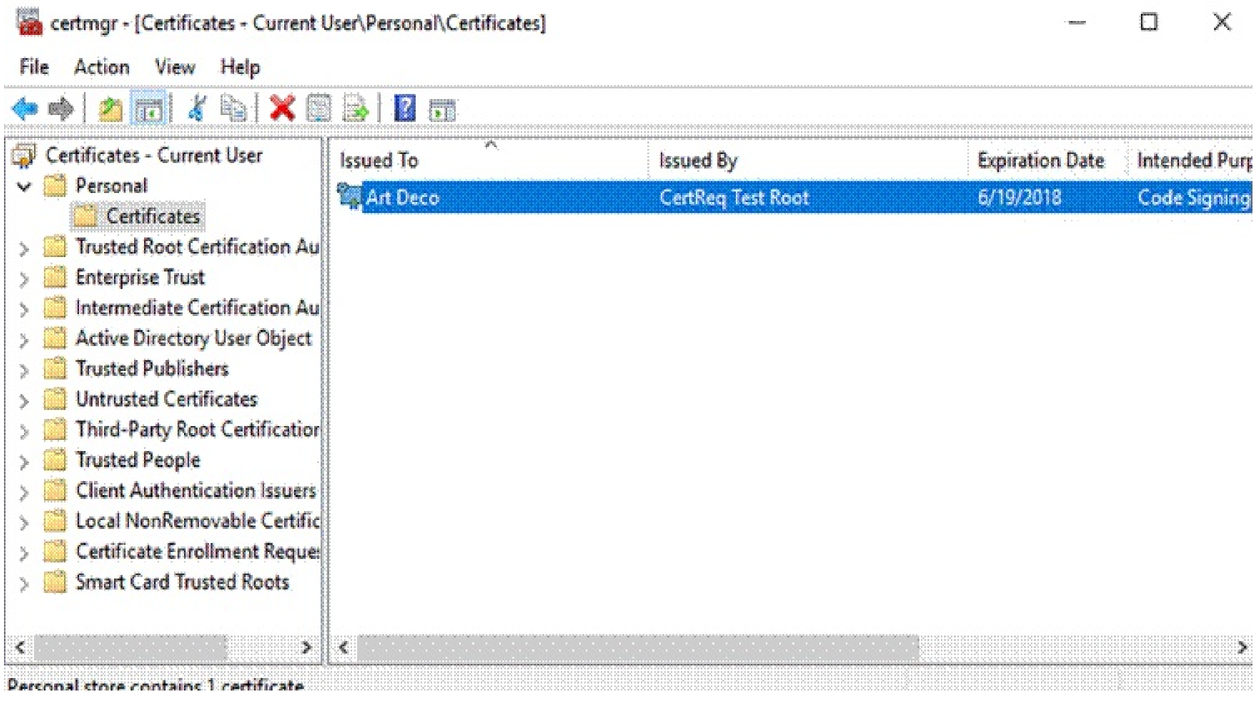


Figure 21.2 Moving the self-signed root certificate

You'll be prompted with a warning dialog box. Go ahead and install the certificate. Now you won't get PowerShell error messages about an untrusted root when you use a certificate that was created by your own computer.

NOTE

It’s important to know that this procedure won’t compromise your computer; it’ll just make it trust the certificates that it produced. Certificates produced elsewhere will still need to be trusted in the usual fashion.

21.4.3 Signing your scripts

To sign a PowerShell script, you need a reference to the certificate. We find it easy to save the code-signing certificate to a variable:

```
PS C:\> $cert = dir Cert:\CurrentUser\My\ -CodeSigningCert
```

You may want to add this type of line to your PowerShell profile script so that it’s always available. In our scripts directory, we have an extremely simple PowerShell script:

```
PS C:\scripts> get-content psvm.ps1
get-process | sort vm -desc | select -first 5
```

The cmdlet we’ll use is called `Set-AuthenticodeSignature`. That is a lot to type and a good reason to use Tab completion. But because you’re likely to be signing scripts interactively, we suggest creating an alias in your PowerShell profile:

```
Set-Alias -Name sign -Value Set-AuthenticodeSignature
```

We’ll use this alias if for no other reason than to keep our examples short:

```
PS C:\scripts> sign .\psvm.ps1 -Certificate $cert
    Directory: C:\scripts
SignerCertificate                         Status
-----------------                         ------
9D16AF2573AC6C01A33752CA5135F3700A6FE9CFCN Valid              psv
```

Here’s what the file looks like now:

```
PS C:\scripts> get-content .\psvm.ps1
get-process | sort vm -desc | select -first 5
# SIG # Begin signature block
# MIIFWAYJKoZIhvcNAQcCoIIFSTCCBUUCAQExCzAJBgUrDgMCGgUAMGkGCisGAQQ
```

```
# gjcCAQSgWzBZMDQGCisGAQQBgjcCAR4wJgIDAQAABBAfzDtgWUsITrck0sYpfvN
# AgEAAgEAAgEAAgEAAgEAMCEwCQYFKw4DAhoFAAQUWlS7aTI+/TUJU7Izf4mzM8b
# HmWgggL6MIIC9jCCAd6gAwIBAgIQYcqwRS2cF6ZKK2DMJNsC6DANBgkqhkiG9w0
# AQsFADATMREwDwYDVQQDDAhBcnQgRGVjbzAeFw0xNzA2MTkxNDQ5NDZaFw0xODA
# MTkxNTA5NDZaMBMxETAPBgNVBAMMCEFydCBEZWNvMIIBIjANBgkqhkiG9w0BAQE
# AAOCAQ8AMIIBCgKCAQEAotwzL7nKq3uG1oZ/uMAwSELAeVaoIqFHr+zW1hWwW+U
# h/dftEaGsAmETjPnYRkABkGLqloiXXhmLQjY+QKtn51cue78B85mrSF5dqrfuuK
# XIVm7rjvMGwqyU6mpCs2RA3c+eObqgQZMJeOd/U9BnawlUijTcYGXptxc7M7ewW
# oVGSm2C385hB09pZJ5UpmonW81iZZ+nkoos1oMC2jdhdETR2JC/cfpjU1sP406E
# s2gR5jIiZuBBzTMgAlU4IRU38gXiS8q2UA3oyysyd2/+svRgDx/SrO+HV5ZmEqi
# epsY8DpaWn86MLYn+rjPSLgPbW6SNkwvHg58trEsIwIDAQABo0YwRDAOBgNVHQ8
# Af8EBAMCB4AwEwYDVR0lBAwwCgYIKwYBBQUHAwMwHQYDVR0OBBYEFH1ccCLNFjh
# ZqYdX2NvAASUku2PMA0GCSqGSIb3DQEBCwUAA4IBAQCXxfRfgI4KbsvXk0HKVI6
# fJ4CAXDJaZyx2WtuaH4HF1WjhPMh9JjupA2244p/vH1FWERZ5llwR9AcwA8kK8E
# 6aPD5Nu0MGis7gFvzK1K/dnxmgv+7ICS9j92GM4qIa8bcfIwBTTPehQKaJS2Q+b
# cm3eipPI4nxPPhSXLdg3FcglNfwU3aqQznHfmWj5cVgiqtMbe/CBh9hDcCFeW+y
# X6aAY1q+ADrMjILnhOETFpIn3eHmdHiC/q0PpKGJzn+uhwLncaVnahRaSXhIbAp
# /9VqkPEg4kJFYVbewIeOjPWB+2IVtdtgag9X9HwTTP4nEIQ7KEz4jKMM9hPGacn
# MYIByDCCAcQCAQEwJzATMREwDwYDVQQDDAhBcnQgRGVjbwIQYcqwRS2cF6ZKK2D
# JNsC6DAJBgUrDgMCGgUAoHgwGAYKKwYBBAGCNwIBDDEKMAigAoAAoQKAADAZBgk
# hkiG9w0BCQMxDAYKKwYBBAGCNwIBBDAcBgorBgEEAYI3AgELMQ4wDAYKKwYBBAG
# NwIBFTAjBgkqhkiG9w0BCQQxFgQUsoYetaVPGXeBkFV4ddJTInDikFwwDQYJKoZ
# hvcNAQEBBQAEggEARmE9VVlQ+HMYTFnOQ+lJGLvOcm7RKi5+pEVFhxTwoahbu6Z
# oZLEB6zUKx2RxLWkO1+FWiOJWGAAARPnNWCCxBKqAnedtqPNc0UVQ0J5gxuVzfO
# J5Q+3Uu7YbrbgeErC/hYOMmu9hY8a7H7ttxD0p0qHscV7R1kOSxrUGehU3+KLKF
# heKQlOL26DVGdk3KRayZTGzpDXHavkGAtcjcyiQPSPyRdmFcagdZ4VzrKzTT4m1
# i+uHap5xQ80EQBxfgHZT3yXKRA1tl9Mgnmi9XNcUro25i0tiKZTjkZe0voPJ7MX
# ePgJFLinSiRvIvzoqpOgN51CfQ/yWWdCsH+v4w==
# SIG # End signature block
```

You shouldn’t need to mess with the signature block unless you want to completely delete it. That’s the only way to unsign a file.

You can also easily sign an entire directory full of scripts:

```
PS C:\scripts> dir *.ps1 | sign -Certificate $cert -WhatIf
What if: Performing the operation "Set-AuthenticodeSignature" on
"C:\scripts\DirReport.ps1".
What if: Performing the operation "Set-AuthenticodeSignature" on
"C:\scripts\psvm.ps1".
What if: Performing the operation "Set-AuthenticodeSignature" on
"C:\scripts\lastdayofwork.ps1".
What if: Performing the operation "Set-AuthenticodeSignature" on
"C:\scripts\newhire.ps1".
```

You can sign .ps1, .psm1, and .ps1xml files.

TIP

Note that you can't sign .psd1 files, which are a manifest for a script module. If you allow the execution of unsigned scripts on your system, then in theory a piece of malware could find a .psd1 file and modify it to load a malicious script when you loaded your otherwise-all-signed module! It's a risk, but to be fair, that same piece of malware could attack you in a few dozen other ways, too. Be aware of the possibility so that you can be extra cautious when the situation calls for it.

21.4.4 Testing script signatures

Use `Get-AuthenticodeSignature` to test a script's signature:

```
PS C:\scripts> Get-AuthenticodeSignature .\psvm.ps1
    Directory: C:\scripts
SignerCertificate                         Status
-----------------                         ------
9D16AF2573AC6C01A33752CA5135F3700A6FE9CF  Valid               psv
```

The output from `Get-AuthenticodeSignature` is another type of object. The object properties are self-explanatory:

```
PS C:\scripts> Get-AuthenticodeSignature .\psvm.ps1 | select *
SignerCertificate      : [Subject]
                           CN=Art Deco
                         [Issuer]
                           CN=CertReq Test Root, OU=For Test Purp
                         [Serial Number]
                           5B0A36A612E5A78F400FEE5F02F930BB
                         [Not Before]
                           6/19/2017 10:07:53 AM
                         [Not After]
                           6/19/2018 10:27:53 AM
                         [Thumbprint]
                           9D16AF2573AC6C01A33752CA5135F3700A6FE9
TimeStamperCertificate :
Status                 : Valid
StatusMessage          : Signature verified
Path                   : C:\scripts\psvm.ps1
SignatureType          : Authenticode
IsOSBinary             : False
```

If you didn’t follow our suggestion to install the self-signed root certificate, you’ll see an “unknown error” status. That’s kind of okay, but you won’t be able to run the script.

If you have an AllSigned execution policy, you can still run the script:

```
PS C:\scripts> set-executionpolicy allsigned -force
PS C:\scripts> .\psvm.ps1
Do you want to run software from this untrusted publisher?
File C:\scripts\psvm.ps1 is published by CN=Art Deco and is not t
your system. Only run scripts from trusted publishers.
[V] Never run  [D] Do not run  [R] Run once  [A] Always run  [?]
(default is "D"): a
Handles  NPM(K)    PM(K)      WS(K)     CPU(s)     Id  SI Process
-------  ------    -----      -----     ------     --  -- -------
   1179      80    73368        472       9.31    376   2 SearchU
    873      44    67712      43888     579.25    472   0 svchost
   3395     194    97616      27868     446.81   1116   0 svchost
    948      29    56096      22904       2.19   4920   2 powersh
    876      37    99696      47176       4.33   6080   0 powersh
```

The first time we run the script, we’re prompted about trusting the certificate. We’ll go ahead and tell PowerShell to always trust it, and from then on we can run the script with no prompts.

Now we’ll make a slight change to the script, but without re-signing it, and attempt to run it:

```
PS C:\scripts> .\psvm.ps1
File C:\scripts\psvm.ps1 cannot be loaded. The contents of file
C:\scripts\psvm.ps1 might have been changed by an unauthorized us
process, because the hash of the file does not match the hash sto
digital signature.
The script cannot run on the specified system. For more informati
Get-Help about_Signing..
    + CategoryInfo          : SecurityError: (:) [], PSSecurityEx
    + FullyQualifiedErrorId : UnauthorizedAccess
```

We get a rather severe error message, and the script isn’t executed. We want that! If we didn’t make any changes, we want to investigate and figure out what changed. When ready, we can re-sign the script and be ready to go.

21.5 Summary

Implementing script signing isn’t that difficult, especially if you have an Active Directory PKI (which ends up being easier and cheaper than a commercial CA) or another brand of PKI internally. You can probably even configure your scripting editor to sign scripts for you—many of them offer an option to do that when you save the file. If nothing else, it’s a snap to sign all of your scripts at once. As we’ve explained before, implementing digital signatures or requiring their use isn’t a security boundary. But it adds a critical safety check to ensure that the script you, or someone else, are about to run is *exactly* the script you wrote.

22 Publishing your script

We hope that as you progress through this book, or shortly thereafter, you'll develop a fantastic, well-crafted PowerShell tool that solves an immediate problem. It would be even more rewarding if it leads to a substantial raise for you. However, beyond personal gains, we hope you'll consider sharing your creation with the broader PowerShell community. In recent years, this has become conveniently achievable through the Microsoft PowerShell Gallery, which hosts thousands of modules and scripts.

22.1 The Importance of Publish?

Publishing your script offers several benefits. Firstly, it's an altruistic act, contributing positively to the broader PowerShell community. We'd like to express our gratitude in advance for your willingness to do so. Moreover, it is an excellent means to share your tools with colleagues or yourself. You can publish your current version to the PowerShell Gallery (often called PSGallery) and install or update it as needed. If you have a new version, you can also effortlessly publish it. The beauty is that your older versions remain accessible, allowing you to test or reference them when necessary.

22.2 Exploring the PowerShell Gallery

The PowerShell Gallery is a free website maintained by Microsoft, accessible at www.powershellgallery.com. Although you can interact with it directly, you're more likely to use a set of PowerShell cmdlets like `Find-Module` and `Install-Module` for most interactions. Microsoft has implemented stringent checks during script uploads to ensure adherence to best practices. They also employ the PowerShell Script Analyzer commands to scrutinize your code. Initial rejection is possible if your code fails specific tests. To ensure a smooth experience, consider using VS Code for development, as it can help you pass these tests. It's crucial to remember that Microsoft cannot guarantee the effectiveness of a module, so you run anything you download at your own risk. This underscores the importance of maintaining a robust testing

environment.

22.3 Other Publishing Options

While we emphasize the Microsoft PowerShell Gallery's accessibility, it's essential to know that it's essentially a specialized type of website functioning as a NuGet-based repository. NuGet-based repositories have long been recognized as a reliable publication and distribution mechanism. Anyone can establish a NuGet-based repository, and your organization may even have one. While we won't delve into the intricacies of setting up and managing such servers in this book, publishing them from PowerShell should closely mirror what we've discussed for the PowerShell Gallery.

22.4 Before You Publish

Before you publish, we assume your project is complete, tested, and properly documented. This means it includes at least comment-based help. Your project reflects you, so you want to make the best impression possible. But there are a few other preliminary things to check off first.

22.4.1 Are you reinventing the wheel?

Although there’s no rule against publishing something already existing, it’s worth double-checking. Is there already a module that offers the same functionality as yours? How is yours different? Use `Find-Module` to see what existing modules may compete with yours.

Suppose you have a module with some AD-related commands. You can run this:

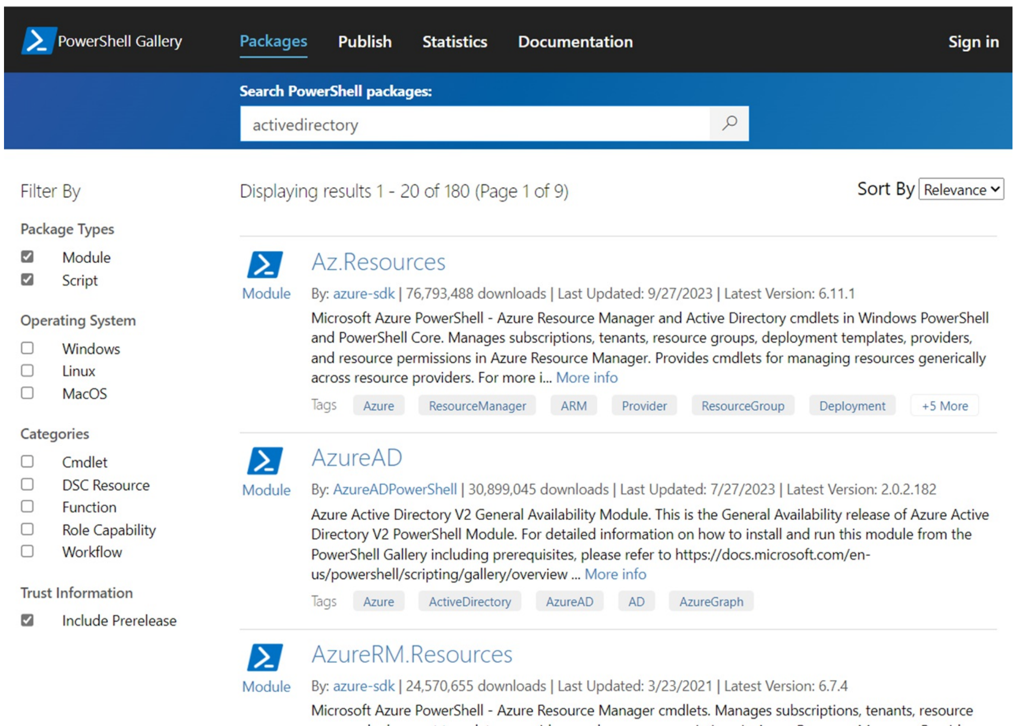
```
find-module *activedirectory* | Select Version,Name,Author, `
 Description,PublishedDate
```

or search by tags:

```
find-module -tag ad,activedirectory
```

You can also use your web browser by visiting powershellgallery.com and searching. You can even refine your search-specific types and categories on the website.

Figure 22.1 PowerShell Gallery Search for Active Directory



You can also search for modules that are operating system specific. Or for those that are cross platform. The tags can easily determine this. For example, let's look at the DBATools module. If we expand the Package Details section, we can see the tags for Mac and Linux. This means that DBATools can be run on PowerShell that is installed on any of these operating systems.

Figure 22.2 Shows DBATools with Mac and Linux tags

22.4.2 Updating Your Manifest

You’ll need a proper manifest, as generated by `New-ModuleManifest`. In it,

make sure you configure these settings:

- `ModuleVersion`—The accepted standard is known as *semantic versioning*. Technically, your value should be in the format *a.b.c.*, such as 1.0.0. But you can get by with something like 1.0.
- `Author`—This will most likely be your name. Try to use the same value on all of your projects so people can identify what belongs to you. Don't use "Don Jones" on one and "Donald Jones" on another. Pick one and live with it. The only way to change it is to publish a new version.
- `Description`—This is a biggie. You need to provide complete information about why your module exists, what problems it solves, and how it's different from related projects.
- `PrivateData`—This too is a biggie, because Microsoft will pull values from the manifest to populate metadata for your project in the gallery:
  - `Tags`—You should enter at least one tag. You can enter as many as make sense, separated by commas. Take a look at existing modules to get a sense for what tags people are using.
  - `LicenseUri`—Ideally, your project is also in a publicly accessible source control system like GitHub. Insert the address to your license file here, which of course you have.
  - `ProjectUri`—This can be the URL to your GitHub repo or wherever your project lives online. Some people like to be able to check your source code. Or, in the case of GitHub, use the Issues feature to report bugs or ask questions.

We assume you've already set the expected values for things like `RootModule`, `Guid`, and `FunctionsToExport`.

22.4.3 Getting an API key

Before publishing to the PowerShell Gallery, you need to be a registered user with an API key. On the PowerShellGallery.com website, click the Register link and follow the instructions. (Websites change so that we won't bother with screenshots.) At some point in the process, you'll get an API key. You can always find your key by logging in and clicking your name to view your profile. You should see the Credentials section. Click the Show Key link to see everything. Assuming you have a secure computer, you might consider

putting your API Key into a password manager or key vault and using the PowerShell Secrets Module to retrieve it. Or you can copy the value and, in your PowerShell profile, create a variable:

```
$PSGalleryKey = 2XXXX7bd-771d-9999-8XXa-da41XXXX1abc
```

However, we prefer the first option. This will come in handy when it comes time to publish your module.

22.5 Ready, Set, Publish

When you publish a module to the PowerShell Gallery, the `Publish-Module` cmdlet will create a NuGet package from your module folder. The person who installs the module will, in essence, get a copy of your folder. Remember when your Mom told you to clean your room because the company was coming over? This is like that. Deleting any temporary, scratch, or otherwise superfluous files from your directory takes a few minutes. If you're using git, the hidden .git directory will be ignored. If you need to retain files for development that aren't part of the final project, you can create a separate, clean directory with just the module files.

If you have a well-constructed manifest, you should be able to run a command like this:

```
Publish-Module -path c:\scripts\MyTools -repository PSGallery -nu
```

In this example, we use the saved API key we set earlier. If you didn't complete your manifest as we suggested, you should run the command and specify additional parameters like `-Tags` and `-FormatVersion`.

Unfortunately, you cannot publish your module without pushing it to the PowerShell Gallery. We'd love to have an option to publish or save the package locally so we could verify its contents before sharing it with the world. The best you can do is save the module from the PowerShell Gallery and look at the downloaded files. If you don't like something, update your module, increase the version number, and republish.

22.5.1 Managing revisions

At some point, you may improve your module or fix bugs. You can republish your module to the PowerShell Gallery using the same steps. The most important task to remember is to update the version number in your module manifest. Users can get the most recent version when they run `Update-Module`.

Once your module is published, there's no way to manage it through PowerShell—you'll have to use the PowerShellGallery.com page. To do so, follow these steps:

1. Sign in to your account.
2. Click your account name link.
3. Click Manage My Items.
4. Select a module from the list.
5. Scroll down the page until you see the Version History section. You can't delete anything, but you can hide a version. Click a link under Listed. All versions probably say Yes.
6. Uncheck the box on the next page to disable showing this particular version in search results.
7. Click Save.

Now, nobody will be able to see this version with `Find-Module`.

On the module page, you'll also see an Edit Module link. You can modify a few things, like the module description and summary, which appear in Additional Metadata when you use `Find-Module`. These are the same items you can configure in your module manifest, which is a better place to make those changes.

22.6 Publishing scripts

Your module should have all the functions and tools you need. How you might use them will be done with a controller script. The controller script automates the process so that instead of having to type a specific sequence of actions using commands from your published module, all you need to do is run the script. You might want to share your controller scripts. Microsoft recently provided an online repository for scripts, which might be an option.

22.6.1 Using the Microsoft script repository

You can find scripts with the `Find-Script` cmdlet. You can run it without parameters or search for something in a script name:

```
PS C:\> find-script *weather*
Version    Name                 Repository    Description
-------    ----                 ----------    -----------
1.0        Get-Weather          PSGallery      Shows Weather infor
```

With our example you may see a warning message or two, which appears to be related to an issue with a script in the repository and not anything you've done wrong locally or in running `Find-Script`.

If you see a script you like, you can save it to a folder so you can inspect it, which of course you will:

```
PS C:\> save-script get-weather -path c:\dltemp
```

You can now look at the file—in our case, c:\dltemp\get-weather.ps1—and decide what to do with it. If you like it, you can copy it to your scripts directory, or you can take advantage of a PowerShell feature and install it:

```
PS C:\> install-script get-weather
PATH Environment Variable Change
Your system has not been configured with a default script install
yet, which means you can only run a script by specifying the full
the script file. This action places the script into the folder 'C
Files\WindowsPowerShell\Scripts', and adds that folder to your PA
environment variable. Do you want to add the script installation
'C:\Program Files\WindowsPowerShell\Scripts' to the PATH environm
variable?
[Y] Yes  [N] No  [S] Suspend  [?] Help (default is "Y"): y
```

As you can read from the prompt, installed scripts go into a specific directory, which is added to the path:

```
PS C:\> get-command get-weather
CommandType    Name            Version Source
-----------    ----            ------- ------
ExternalScript Get-Weather.ps1         C:\Program Files\WindowsPo
PS C:\> get-command get-weather |  Select path
Path
```

```
----
C:\Program Files\WindowsPowerShell\Scripts\Get-Weather.ps1
```

As an added benefit, you don't need to specify the full path to the script file. You can type the name of the script, and it will run:

```
PS C:\> get-weather "Austin"
Weather report: Austin
     \   /     Sunny
      .-.      100-102 °F
   ― (   ) ―   ↙ 0 mph
      `-’      9 mi
     /   \     0.0 in
```

Like modules, you can also update and uninstall scripts. And, even better, you can publish your own scripts. As with modules, the whole world will see your code. So make sure it's clean, well-documented, and includes all the other things we've talked about that you should be doing as a professional toolmaker.

22.6.2 Creating ScriptFileInfo

Before you can publish a script, you need to create a special type of header that includes all the necessary metadata such as tags, versioning, and requirements. You do this with the `New-ScriptFileInfo` cmdlet. You can either append your script code to this file or move the comment block to your script file. Using an example by Jeff Hicks we'll demonstrate by publishing one of Jeff's scripts that checks for module updates in the PowerShell Gallery:

```
PS C:\> New-ScriptFileInfo -Path C:\Work\sfi.ps1 -Version 1.0.0 -
```

The filename must have a .ps1 file extension. Here's the result. The headings should be self-explanatory and are similar to what you'd use in a module manifest:

```
<#PSScriptInfo
.VERSION 1.0.0
.GUID 7da2acc6-30d8-4cc9-a3d9-ba645fceebb2
.AUTHOR Jeff Hicks
.COMPANYNAME
```

```
.COPYRIGHT 2023
.TAGS PowerShellget Module PSGallery
.LICENSEURI
.PROJECTURI
.ICONURI
.EXTERNALMODULEDEPENDENCIES
.REQUIREDSCRIPTS
.EXTERNALSCRIPTDEPENDENCIES
.RELEASENOTES
#>
<#
.DESCRIPTION
 Check for module updates from the PowerShell gallery and create
comparison object
#>
Param()
```

Take everything except the `Param()` line, and move it to the beginning of the script file. We'll clean it up a bit and verify that we haven't messed up anything:

```
PS C:\> Test-ScriptFileInfo -Path C:\scripts\Check-ModuleUpdate.p
Name                       : Check-ModuleUpdate
Version                    : 1.0.0
Guid                       : 7da2acc6-30d8-4cc9-a3d9-ba645fceebb2
Path                       : C:\scripts\Check-ModuleUpdate.ps1
ScriptBase                 : C:\scripts
Description                : Check for module updates from the Po
                             gallery and create a comparison obje
Author                     : Jeff Hicks
CompanyName                :
Copyright                  : 2023
Tags                       : {PowerShellget, Module, PSGallery}
ReleaseNotes               : {This code is described at
http://jdhitsolutions.com/blog/powershell/5…}
RequiredModules            :
ExternalModuleDependencies :
RequiredScripts            :
ExternalScriptDependencies :
LicenseUri                 :
ProjectUri                 : https://gist.github.com/jdhitsolutio
IconUri                    :
DefinedCommands            :
DefinedFunctions           :
DefinedWorkflows           :
```

We didn't get any errors, so we'll assume we're good. Once you have something like this, it's simple to keep as a snippet or file that you can copy, paste, and modify as necessary. Just be sure to generate a new GUID, using the `New-Guid` cmdlet, for each new script you intend to publish.

22.6.3 Publishing the script

Publishing a script to the PowerShell Gallery also requires the API key. Once you've updated the script file with the necessary metadata, you can easily publish it:

```
Publish-Script -Path C:\scripts\Check-ModuleUpdate.ps1 -NuGetApiK
```

In less than a minute, the script will be available for download and installation:

```
PS C:\> find-script check-moduleupdate
WARNING: Unable to resolve package source ''.
WARNING: Cannot bind argument to parameter 'Path' because it is a
Version  Name                  Repository  Description
-------  ----                  ----------  -----------
1.0.0    Check-ModuleUpdate    PSGallery   Check for module update
```

You may see a different version, depending on changes Jeff makes and republishes.

22.6.4 Managing published scripts

As is true for published modules, there are no commands in PowerShell for managing a published script. If you need to change the script, do so, and then edit the script file-info header with a new version. You should be able to run `Publish-Script` as you did before.

You can also use the Manage My Items page on PowerShellGallery.com, as we showed you earlier, for modules. Scroll down the list until you find the script. You'll see that it has a Script type. As with modules, you can't delete published items but can hide previous versions. Follow the same steps as described earlier.

22.7 Summary

There’s no requirement that you publish or share your modules and scripts, but this is a relatively painless process to make your beautiful code available to everyone who needs it. In the long run, we think Microsoft will offer more guidance and tools for IT pros to set up internal repositories, which makes a ton of sense. In the meantime, you can become familiar with the process by publishing to the PowerShell Gallery.

23 Squashing bugs

No comprehensive scripting guide is complete without addressing the critical topic of debugging. To put it bluntly: debugging can be frustrating. But don't worry; we're here to offer some valuable insights and practical tips to make debugging more manageable for you.

23.1 The three kinds of bugs

In the world of scripting, bugs generally fall into three categories: syntax, results, and logic bugs. Recently, a new category, "results bugs," has emerged to help address specific scenarios that often perplex scriptwriters. These bug families, in ascending order of complexity, are as follows:

- *Syntax bugs*—You typed something wrong. Perhaps you typed *FerEach* instead of *ForEach*, for example, or you forgot to close a `{` curly bracket. PowerShell will try to alert you to many syntax bugs by using a little red squiggly underline thingy. But there’s a more insidious class of syntax bugs that PowerShell can’t help with Mistyping a variable name in a script—for example, *$CmputerName* instead of *$Computer-Name*—will create undesired results, but PowerShell won’t be able to help by default. If you’re using VS Code, you may see a red squiggle under the variable until you use it somewhere else in your script.
- *Results bugs*—A command produces something you don’t expect. For example, if you expect `Test-Connection SERVER1` to return $True when SERVER1 is online, you’ll be disappointed when it doesn’t, and the code that made that assumption might not work the way you expected.
- *Logic bugs*— These are the trickiest to resolve because they don't result in obvious errors. Logic bugs occur when your script's commands execute without error, but there's an issue in how your code is structured or written. We'll dedicate the majority of this chapter to help you conquer logic bugs.

An almost fourth category: : the PowerShell “gotcha”

Here's a unique situation that could be considered a blend of syntax and results bugs. Consider the following command:

```
Get-CimInstance –ClassName Win32_OperatingSystem |
Select-Object –Prop PSHostName,Version,BuildNumber
```

This command runs without errors, but it produces output with one blank column. The peculiar part is the `PSHostName` property requested with `Select-Object`. The CIM class we've retrieved doesn't have a `PSHostName` property. PowerShell, however, can create new properties on the fly, which can be useful in many situations. In this case, it has created a new property named `PSHostName` without any content. If you later rely on `PSHostName` having values, you won't get the expected results. For now, let's classify this as a results bug and refer you to section 23.3.

23.2 Dealing with syntax bugs

The simplest way to handle syntax bugs is never to make a typo and to pay attention to PowerShell's red squiggly underlines, which highlight potential issues. Additionally, you can enhance your script's reliability by adding `Set-StrictMode –Version 2.0` at the script's beginning. This command modifies PowerShell's behavior in the following ways:

- You're supposed to call PowerShell functions using a specific syntax. For example, a function that has three input parameters could be called by running `My-Function 1 2 3`, passing the values 1, 2, and 3 to the parameters in order. Newcomers sometimes use a method-style syntax like `My-Function(1,2,3)`, which passes a single array of three elements to the first parameter. Strict mode disallows that and will throw an error. You can avoid the problem condition by always using named parameters when calling a function, as in `My-Function –Param 1 –OtherParam 2 –ThirdParam 3`.
- Referring to nonexistent properties of objects normally returns a `$null` value; in strict mode, doing so produces an error. This will *not* solve the `Select-Object` gotcha we described in the sidebar earlier—that condition is, as we noted, a specific *feature* of the command.
- Referring to a variable that hasn't been assigned a value in the current

scope will normally cause PowerShell to go up the scope tree to try and find the variable. For example, referring to $ErrorActionPreference in a script works because the global scope, rather than your local scope, contains that predefined variable. In strict mode, this behavior changes. Referring to variables that haven't yet been assigned a value in the current scope will produce an error. This helps avoid "I mistyped the variable name—argh!" syntax errors.

We recommend using strict mode in all of your scripts. We don't do so in all of our sample and demo code, but that's because they aren't production-ready files.

Using the latest version

You might have noticed that the -Version parameter for `Set-StrictMode` also offers a "Latest" option. While using "Latest" seems like a convenient choice, it's essential to consider the potential consequences. As of now, "2.0" is the latest documented version, making it a safer choice. You can be confident that your code will work as expected with version 2.0. If Microsoft introduces a "3.0" option in the future, you may want to revisit your code, as significant changes to PowerShell could accompany it.

23.3 Dealing with results bugs

To tackle results bugs, follow the scripting process we've advocated throughout this book. Always begin by running individual commands directly in the console before incorporating them into your scripts. This way, you can observe the actual output and establish reliable expectations based on concrete evidence. Although this may seem overly simplistic, it's a step often overlooked by scriptwriters in their haste to create code.

23.4 Dealing with logic bugs

Now, let's delve into the most challenging category: logic bugs. We've uncovered a straightforward rule that simplifies the process of identifying and fixing logic bugs: logic errors occur when a property or variable contains

something different from what you assumed. To illustrate this concept, consider the script in listing 23.1: It contains a function that's supposed to get disk information using `Get-CimInstance` command.

TRY IT NOW

Go ahead and grab this script from the downloadable code samples at http://www.manning.com/books/learn-powershell-scripting-in-a-month-of-lunches and run it. It won't hurt anything, but it also won't work correctly. If you've run into this issue yourself at some point, the reason will be obvious, but we will use this as an example of the procedure we follow to debug problems like this. We also aren't annotating the code because we want you to follow the debug process.

Listing 23.1 A buggy script for you to consider

```
function Get-DiskInfo {
    [CmdletBinding()]
    Param(
        [Parameter(Mandatory=$True,
                   ValueFromPipeline=$True)]
        [string[]]$ComputerName
    )
    BEGIN {
        Set-StrictMode -Version 2.0
    }
    PROCESS {
        ForEach ($comp in $ComputerName) {
            $params = @{'ComputerName' = $comp
                        'ClassName' = 'Win32_LogicalDisk'}
            $disks = Get-CimInstance @params
            ForEach ($disk in $disks) {
                $props = @{'ComputerName' = $comp
                           'Size' = $disk.size
                           'DriveType' = $disk.drivetype}
                if ($disk.drivetype -eq 'fixed') {
                    $props.Add('FreeSpace',$disk.FreeSpace)
                } else {
                    $props.Add('FreeSpace','N/A')
                }
                New-Object -TypeName PSObject -Property $props
            } #foreach disk
        } #foreach computer
```

```
    } #PROCESS
    END {}
}
Get-DiskInfo -ComputerName localhost
```

The problem with this script, as with all logic bugs, is that we have either a variable or a property that contains something *other than what we thought it did.* In this particular example, which is deliberately simplistic, this is a results-style bug. If we'd bothered to run the command at the console and see what it produced, we wouldn't be in this pickle. But in some scripts, you're populating variables and properties with values that you've calculated or constructed, and so it's more complex than running a command to see what it produces. For this example, we'll treat this as a pure logic bug and follow the procedure for figuring those out.

If the core problem is a property or a variable not containing what you expect, then the fix is to determine which property or variable it contains and determine what it contains. We're going to cover several distinct methods for doing this.

Note

With the advent of VS Code and PowerShell support therein, we've changed our debugging approach. We don't use `Write-Debug` anymore, nor, in most interactive debugging cases like this, do we use `Set-PSBreakpoint` as much. Those are still useful, and in more-advanced books like *The PowerShell Scripting & Toolmaking Book*, we get into their intricacies. For beginning debugging, however, we now rely on VS Code's features.

23.4.1 Setting breakpoints

A *breakpoint* lets you run a script to a specific place; the script will pause when it encounters the breakpoint. That pause lets you examine the script, check the contents of variables and properties, execute the script line by line, or resume normal execution. Breakpoints are your core debugging tool, and they're tremendously useful.

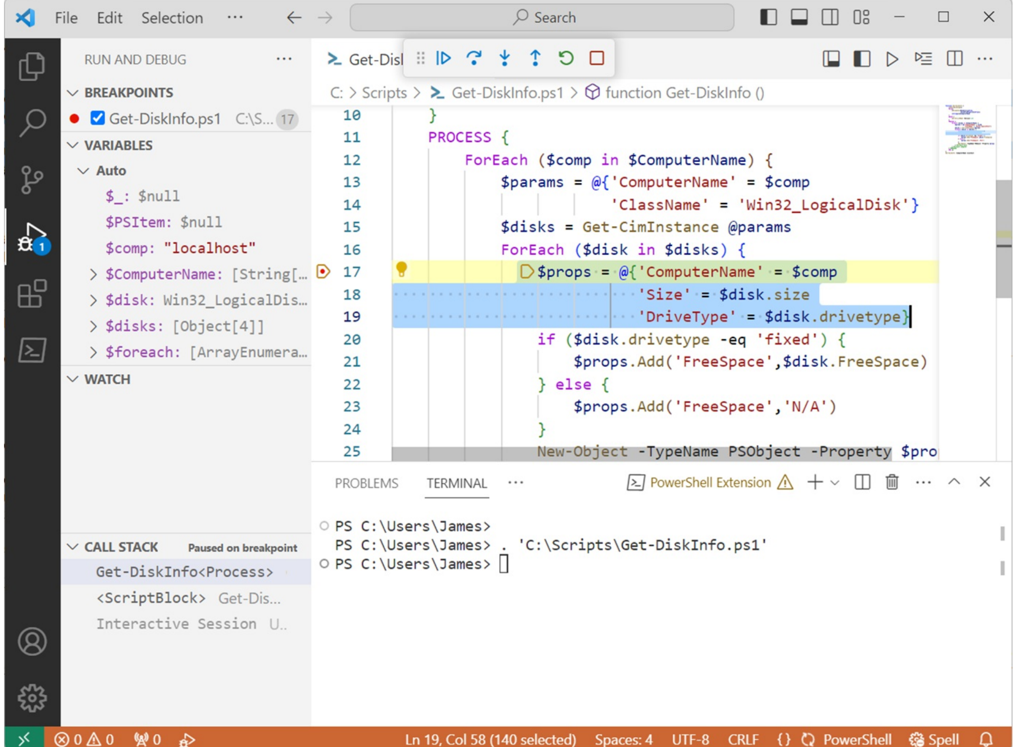
We like to set a breakpoint just after we've set a variable's contents or right

before we’re about to rely on the contents of a variable or a property. Figure 23.1 shows our script in VS Code; we’ve moved to line 17 and pressed F9 to toggle a breakpoint. It displays as a red dot just to the left of the line number.

Figure 23.1 Setting a breakpoint in VS Code

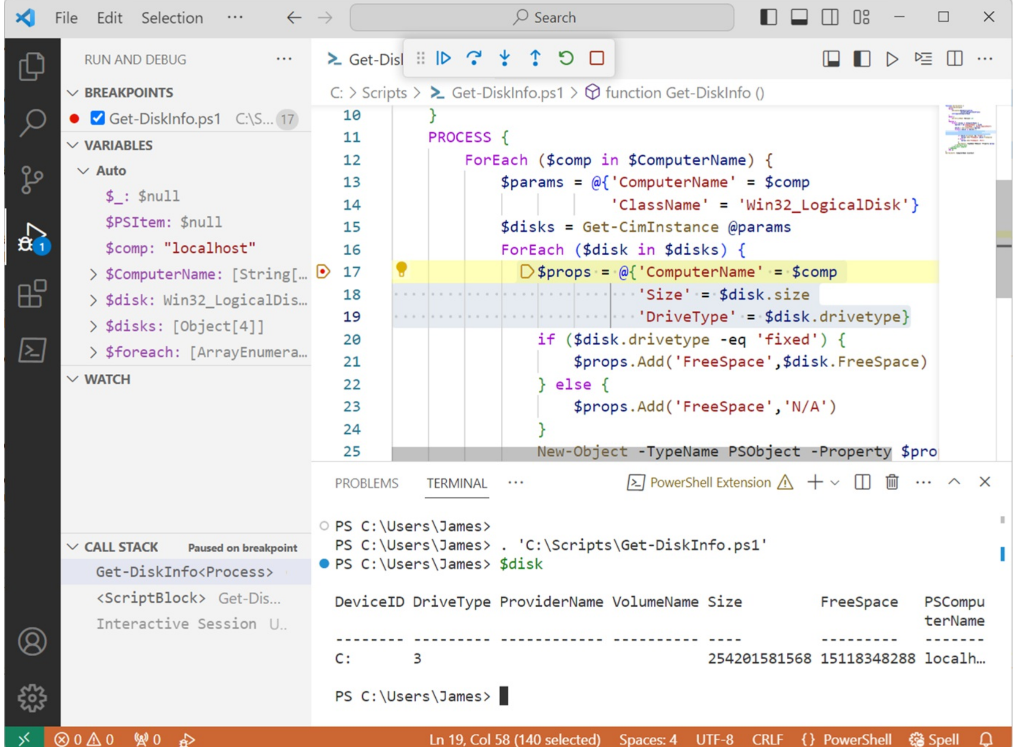
With the breakpoint set, we can press F5 to run the script and begin debugging. Figure 23.2 shows what happens when execution reaches line 17: A Debug pane opens on the left side of the VS Code window, and the PowerShell terminal pane indicates that we’ve hit a breakpoint. The script is paused, and line 17 is highlighted.

Figure 23.2 Hitting a breakpoint in VS Code



While the breakpoint is active, we can use that Terminal pane to examine things. For example, we'll run `$disk` to see what that variable currently contains. Figure 23.3 shows the result.

Figure 23.3 Checking out a variable's contents when in debug mode



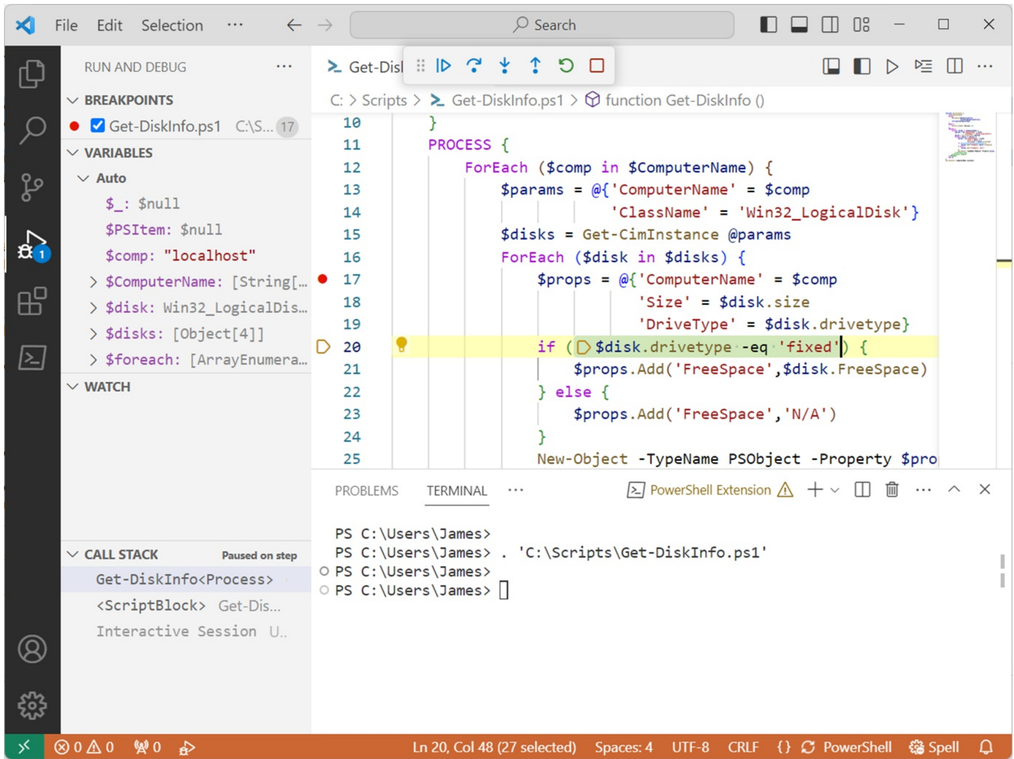
Sharp-eyed readers will have spotted the problem: The `DriveType` property contains 3, but our code clearly expected it to contain a string value like "fixed". Let's pretend for a moment that you're not sharp-eyed—we have another debugging trick up our sleeves.

TRY IT NOW

This next bit is cooler to watch in person than in a book. We suggest that you get VS Code up and running, make sure the PowerShell extension is active, and start a new file. Save the file with a .ps1 filename extension (so VS Code knows it's PowerShell) and paste in the contents of listing 23.1. Set a breakpoint on line 17 as we've done and run the script.

At line 17, the script is just about to enter an `If` construct, where it will make a logical decision. These decisions are often where logic bugs manifest themselves. The script is going to decide whether it will create a `FreeSpace` property that contains an actual free space value, or if it'll insert "N/A" as that value. Press F11, the Step Into command; as shown in figure 23.4, the script will advance one line and pause again. You're about to execute the logic construct.

Figure 23.4 Stepping into the next line of code during debugging



Press F11 once more. The script jumps to line 23—you've able to visually observe the outcome of the logic. That means `$disk.drivetype` definitely doesn't contain “fixed”. You expected it to—and so you've found the exact location of the bug. At this point, you can press Shift-F5 to stop debugging, so that you can begin fixing the problem.

It's all about the expectations

We've skipped a somewhat valuable lesson—or saved it for this specific point. Debugging is all about finding where your assumptions and expectations differ from reality. The implication is that *you have expectations*. In other words, you must have an idea in mind of what your script will do. Debugging will let you observe whether it does those things.

These are your expectations. When it comes time to debug, you're merely comparing reality to those expectations, and where they differ, you've found your bug.

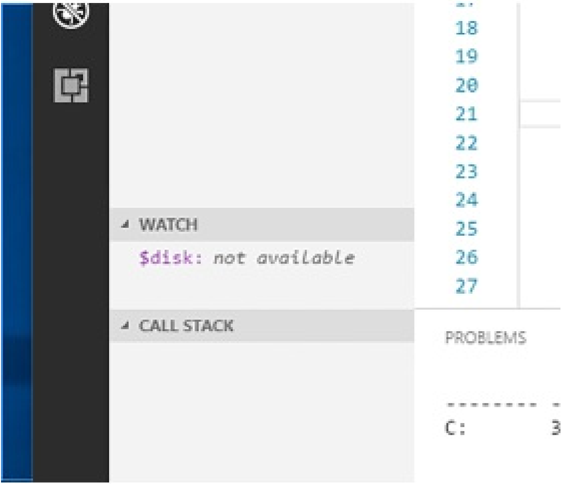
These are your expectations. When it comes time to debug, you're merely comparing reality to those expectations, and where they differ, you've found your bug.

If you don't have an expectation for what the script will do each step of the way, and if you don't have an expectation for what each variable and property will contain, then you can't debug.

23.4.2 Setting watches

Because "what the variables and properties contain" is such a crucial part of debugging, VS Code offers a feature called *watches* that focuses specifically on that part. In VS Code, you can select Remove All Breakpoints from the Debug menu to give yourself a clean slate. The Debug pane is still open, though—press Ctrl-Shift-D if you closed it by accident. Under the WATCH section, click the + icon (it won't be visible until you move your cursor over the WATCH section header). In the text box that appears, type `$disk`, and press Enter. You should have something that looks like figure 23.5.

Figure 23.5 Adding a watch for `$disk`



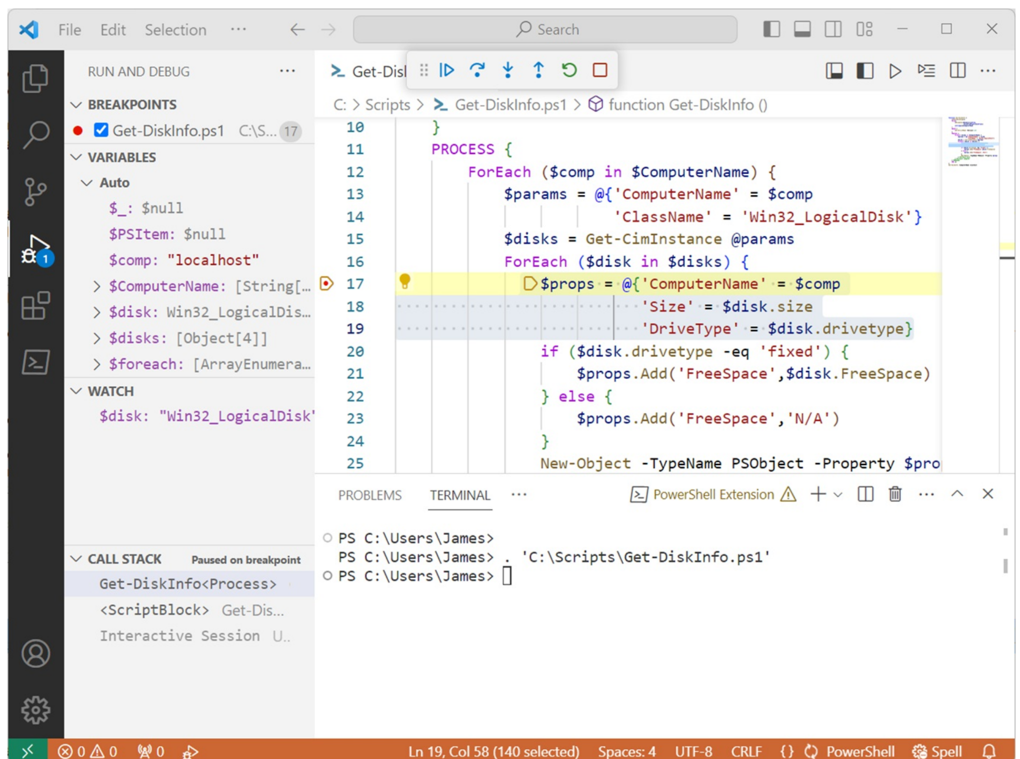
We're seeing that the variable is currently "not available," which makes sense because the script isn't running. We'll re-enable the breakpoint on line 17, which is just after `$disk` is defined in the `ForEach` loop, and then run the

script.

23.4.3 So much more

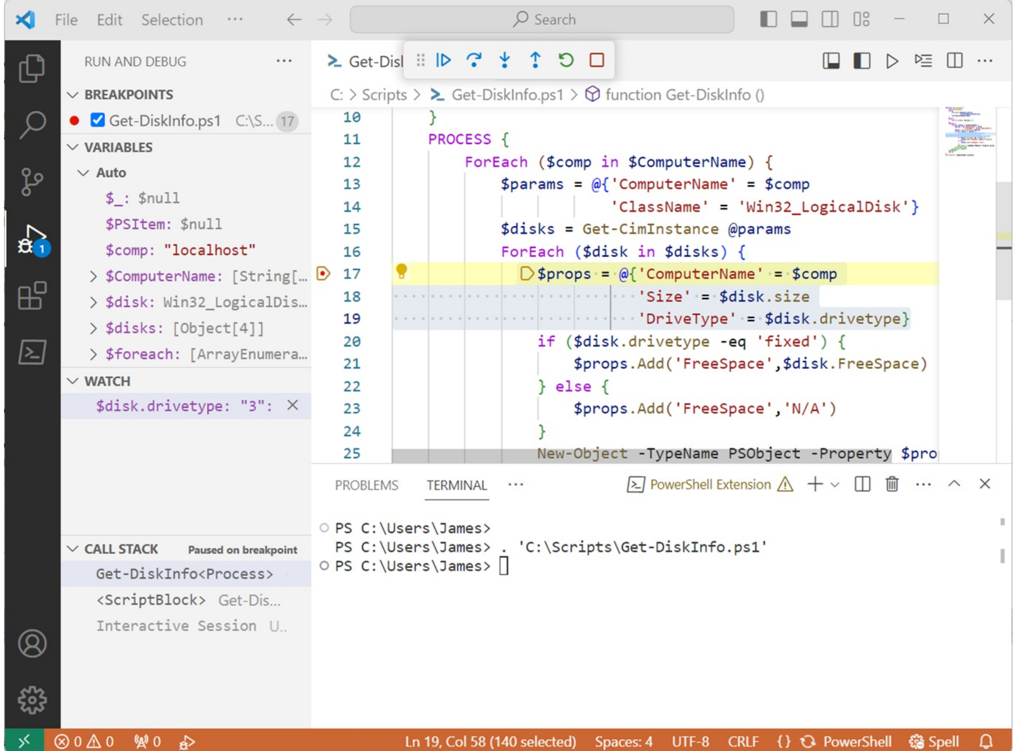
VSCode leverages PowerShell's PSBreakpoint commands to provide these debugging features. There's more to explore beyond what we've covered in this chapter. Read the help documentation for VS Code to learn about the additional capabilities it offers for debugging. While the techniques we've introduced are fundamental, they provide a solid foundation for squashing bugs in your scripts.

Figure 23.6 Watching `$disk` reveals what's in it at this moment.



But you kind of *knew* it was a `Win32_LogicalDisk`. The next *use* of the `$disk` variable is to check the `Size` and `DriveType` properties on line 17. Double-click the watch to edit it. Add `.drivetype` to the end of `$disk`; as figure 23.7 shows, on our system we see that `DriveType` is 3.

Figure 23.7 Modifying the watch to focus on a specific property



The benefit of these watches is that you can press F5 again to run the script until it re-encounters the line 17 breakpoint. On our computer, we'd see `DriveType` change to 5—you'll likely have something different, based on your computer's configuration. And rather than having to type out `$disk.drivetype` every time, you can quickly refer to the watches and see what all of your variables are doing.

23.4.4 Don't be lazy

After all that, you may be thinking, "That's a lot of work." You know what's even more work? Trying to spot a problem by reading the code or making random guesses about what might be wrong. And we've seen real people do exactly that. Take the time to learn the process and your editor's debugging features. It may feel like it's taking forever, but it's still a faster process than debugging by chance.

Oh, and make sure you make only one change at a time. Don't change five things at once, because you won't know which change solves your problem, and you run the risk of introducing more bugs. Change one thing. Test. If it solves your bug, great. If not, change your code back, and try something else.

Also be prepared for the fact that you might have multiple bugs but not see all of them until the first one or two are fixed.

23.5 Your turn

With these few techniques, believe it or not, you're equipped to handle most of the logic bugs you'll write into a PowerShell script. But don't take our word for it—put your new debugging skills to use.

23.5.1 Start here

Listing 23.2 is a buggy script. That's right, *it won't run as is*. We know that —it's the whole point of this exercise. We don't want you to run the script— for now, get it into VS Code, where you can look at it. Be sure to save it as a file with a .ps1 filename extension, or VS Code's PowerShell magic won't activate.

Listing 23.2 A buggy script that awaits your debugging skills

```
Function Get-DiskCheck {
    [cmdletbinding(DefaultParameterSetName = "name")]
    Param(
        [Parameter(Position = 0, Mandatory,
            HelpMessage = "Enter a computer name to check",
            ParameterSetName = "name",
            ValueFromPipeline)]
        [Alias("cn")]
        [ValidateNotNullorEmpty()]
        [string[]]$Computername,
        [Parameter(Mandatory,
            HelpMessage = "Enter the path to a text file of compu
 names",
            ParameterSetName = "file"
        )]
        [ValidateScript( {
                if (Test-Path $_) {
                    $True
                }
                else {
                    Throw "Cannot validate path $_"
                }
            })]
```

```
        [ValidatePattern("\.txt$")]
        [string]$Path,
        [ValidateRange(10, 50)]
        [int]$Threshhold = 25,
        [ValidateSet("C:", "D:", "E:", "F:")]
        [string]$Drive = "C:",
        [switch]$Test
    )
    Begin {
        Write-Verbose "[BEGIN  ] Starting: $($MyInvocation.Mycomm
        $cimParam = @{
            Classname    = "Win32_LogicalDisk"
            Filter       = "DeviceID='$Drive'"
            Computername = $Null
            ErrorAction  = "Stop"
        }
    } #begin
    Process {
        if ($PSCmdlet.ParameterSetName = 'name') {
            $names = $Computernme
        }
        else {
            #get list of names and trim off any extra spaces
            Write-Verbose "[PROCESS] Importing names from $path"
            $names = Get-Content -Path $path | Where {$_ -match "
foreach {$_.Trim()}
        }
        if ($test) {
            Write-Verbose "[PROCESS] Testing connectivity"
            #ignore errors for offline computers
            $names = $names | Where {Test-WSMan $_ -ErrorAction
SilentlyContinue}
        }
        foreach ($computer in $names) {
            $cimParam.Computername = $Computer
            Write-Verbose "[PROCESS] Querying $($computer.toUpper
            Try {
                $data = Get-Ciminstance @cimParam
                #write custom result to the pipeline
                $data | Select Computername,
                DeviceID, Size, Freespace,
                @{Name = "PctFree"; Expression =
{[math]:Round(($_.freespace / $_.size) * 100, 2)}},
                @{Name = "OK"; Expression = {
                        [int]$p = ($_.freespace / $_.size) * 100
                        if ($p -ge $Threshhold) {
                            $True
```

```
                        }
                        else {
                            $false
                        }
                    }
                }, @{Name = "Date"; Expression = {(Get-Date)}}
            }
            Catch {
                Write-Warning "[$($computer.toUpper())] Failed.
 $($_.Exception.message)"
            }
        } #foreach computer
    } #process
    End {
        Write-Verbose "[END    ] Ending: $($MyInvocation.Mycomman
    } #end
}
```

23.5.2 Your task

Begin by *reading* the script. What will it do? What will each variable contain along the way? What will the various properties contain? You may spot several bugs in your read-through—we've included both logic and syntax bugs for your debugging pleasure. Don't assume you've found all the bugs by reading the script.

Once you're finished with the read-through, *debug the script*. Use the techniques we've introduced in this chapter and see whether you can produce a flawless version that runs perfectly. For example, maybe start by finding a good place to enable strict mode and see what PowerShell can help you find.

23.5.3 Our take

This chapter is a lot more about the procedure than the code, but to make sure you found everything, the following listing shows the corrected script. Looking for a fun bonus exercise? We didn't annotate the listing; instead, try using `Compare-Object` to compare listings 23.2 and 23.3, or compare your corrected script to either one of those, to see what changed between them.

Listing 23.3 Buggy script, completely debugged

```
Function Get-DiskCheck {
    [cmdletbinding(DefaultParameterSetName = "name")]
    Param(
        [Parameter(Position = 0, Mandatory,
            HelpMessage = "Enter a computer name to check",
            ParameterSetName = "name",
            ValueFromPipeline)]
        [Alias("cn")]
        [ValidateNotNullorEmpty()]
        [string[]]$Computername,
        [Parameter(Mandatory,
            HelpMessage = "Enter the path to a text file of compu
 names",
            ParameterSetName = "file"
        )]
        [ValidateScript( {
                if (Test-Path $_) {
                    $True
                }
                else {
                    Throw "Cannot validate path $_"
                }
            })]
        [ValidatePattern("\.txt$")]
        [string]$Path,
        [ValidateRange(10, 50)]
        [int]$Threshhold = 25,
        [ValidateSet("C:", "D:", "E:", "F:")]
        [string]$Drive = "C:",
        [switch]$Test
    )
    Begin {
        Write-Verbose "[BEGIN  ] Starting: $($MyInvocation.Mycomm
        $cimParam = @{
            Classname    = "Win32_LogicalDisk"
            Filter       = "DeviceID='$Drive'"
            Computername = $Null
            ErrorAction  = "Stop"
        }
    } #begin
    Process {
        if ($PSCmdlet.ParameterSetName -eq 'name') {
            $names = $Computername
        }
        else {
            #get list of names and trim off any extra spaces
            Write-Verbose "[PROCESS] Importing names from $path"
            $names = Get-Content -Path $path | Where {$_ -match "
```

```
 foreach {$_.Trim()}
        }
        if ($test) {
            Write-Verbose "[PROCESS] Testing connectivity"
            #ignore errors for offline computers
            $names = $names | Where {Test-WSMan $_ -ErrorAction
 SilentlyContinue}
        }
        foreach ($computer in $names) {
            $cimParam.Computername = $Computer
            Write-Verbose "[PROCESS] Querying $($computer.toUpper
            Try {
                $data = Get-Ciminstance @cimParam
                #write custom result to the pipeline
                $data | Select PSComputername,
                DeviceID, Size, Freespace,
                @{Name = "PctFree"; Expression =
 {[math]::Round(($_.freespace / $_.size) * 100, 2)}},
                @{Name = "OK"; Expression = {
                        [int]$p = ($_.freespace / $_.size) * 100
                        if ($p -ge $Threshhold) {
                            $True
                        }
                        else {
                            $false
                        }
                    }
                }, @{Name = "Date"; Expression = {(Get-Date)}}
            }
            Catch {
                Write-Warning "[$($computer.toUpper())] Failed.
 $($_.Exception.message)"
            }
        } #foreach computer
    } #process
    End {
        Write-Verbose "[END    ] Ending: $($MyInvocation.Mycomman
    } #end
}
```

24 Enhancing script output presentation

Throughout this book, our guiding principle has been to help you create tools that excel in doing one thing and one thing only. These tools remain agnostic to the origins of their input, as long as it can be seamlessly channeled to a parameter. Similarly, tools don't concern themselves with the destination or purpose of their output. Consequently, they don't focus on creating beautifully formatted output. You can rely on the built-in Format- cmdlets or `Select`-Object to enhance the aesthetics or cater to management preferences. However, in this chapter, we will delve into two advanced techniques for elevating the visual appeal of your output, surpassing the capabilities of Format- commands.

24.1 Our starting point

We’re going to start with the following code, which we copied from the end of chapter 17.

Listing 24.1 Starting point for this chapter

```
function Get-DiskInfo {
 foreach ($domain in (Get-ADForest).domains) {
   $hosts = Get-ADDomainController -filter * -server $domain |
   Sort-Object -Prop hostname
   ForEach ($host in $hosts) {
    $cs = Get-CimInstance -ClassName Win32_ComputerSystem `
                         # -ComputerName $host
    $props = @{'ComputerName' = $host
               'DomainController' = $host
               'Manufacturer' = $cs.manufacturer
               'Model' = $cs.model
               'TotalPhysicalMemory(GB)'=$cs.totalphysicalmemory
               }
     New-Object -Type PSObject -Prop $props
   } #foreach $host
  } #foreach $domain
```

```
} #function
Export-ModuleMember -function Get-DiskInfo
```

Save this as a new module named Test.psm1, which means it’s in a folder also named Test, under the Documents/PowerShell/Modules folder. Thus, the complete filename is Documents/PowerShell/Modules/Test/Test.psm1. Got all that?

As is, the output isn’t fantastic looking. The code has five properties, which exceeds the property count of four that lets PowerShell create a table by default. That means the output is, by default, returned as a list:

```
PS C:\> get-diskinfo
DomainController        : SRV1
ComputerName            : SRV1
Model                   : Virtual Machine
Manufacturer            : Microsoft Corporation
TotalPhysicalMemory(GB) : 31.5475044250488
```

We don’t like it. Maybe you want a table or specific default properties. But you know not to build any formatting *into the command itself*, because that would break the excellent rules those two great PowerShell guys laid down in their scripting book, right?

24.2 Creating a default view

Instead, let’s take advantage of the formatting system built into PowerShell. The goal is to have your command output always display as a table without using any additional commands to make that happen (such as piping to `Format-Table`). You will create a *default view*, which PowerShell’s formatting subsystem will use automatically, to render the command output. You’ll only change the *visual representation* of the command’s output—you won’t modify the actual output objects in any way.

24.2.1 Exploring Microsoft’s Views

Nearly every native core command you run in PowerShell has a default view defined already. Run `cd $pshome` in PowerShell to switch to PowerShell’s home folder, and then run `Dir`. You’ll see several files with a. format.ps1xml

filename extension. These are the ones we’re after, because they’re where Microsoft defines the default views for the shell’s core commands.

Lies and mysteries

Hopefully, You’re already aware that these default views can make it seem as if PowerShell is lying sometimes. For example, running `Get-EventLog system -newest 10` displays a neatly formatted table (try it!), but some of the column names are different from the underlying property names. That is, when looking at a predefined list or table, the headers are defined in the View and *don’t necessarily represent the underlying objects*. When you run `Get-Process`, the numbers you see are calculated by the default view; the underlying data is in bytes, not kilobytes, or megabytes, or whatever. Views are a visual thing, and you have to be careful about relying on them as descriptors of the actual data in play.

You can do the same sort of lying when you create views. Don’t want the table header to be ComputerName? No problem—you can have it show up as Mandolin if you want. This will create no end of confusion for anyone using your command, because they might try to run something like `Get-Whatever | Select-Object mandolin`, only to get a blank column as the output because there’s no actual “mandolin” property. This continues a fine tradition of PowerShell being a little sneaky.

We should also point out that we’re about to mess with XML files with *no formal definition or document type declaration (DTD).* This is allegedly because Microsoft wants the freedom to tinker with this system in the future (although it never has in 15+ years); if Microsoft doesn’t document the file formats, you can’t complain if they change on you one day. Or so goes the theory. Frankly, we’ve seen the formatting subsystem’s code (PowerShell is open source now, remember!), and we’d be more willing to believe that the company is a little embarrassed by it all and doesn’t want to document it because it brings up painful memories. What documentation does exist is at http://mng.bz/QBX0, and good luck with that—it’s terse.

We document this stuff more thoroughly in *PowerShell in Depth*, if you’re interested (Manning, 2014, https://www.manning.com/books/powershell-in-depth-second-edition). This chapter will serve more as a tutorial than a

comprehensive look at what you can accomplish.

The file to open—in Notepad, VS Code, or your favorite editor, as you prefer—is dotnettypes.format .ps1xml. There are other format files, but this biggie contains the views for most of the core object types PowerShell works with. Let's walk through a bit of it, because you'll be copying from it. It starts like this:

```
<?xml version="1.0" encoding="utf-8" ?>
<!-- *****************************************************************
These sample files contain formatting information used by the Win
PowerShell engine. Do not edit or change the contents of this fil
directly. Please see the Windows PowerShell documentation or type
Get-Help Update-FormatData for more information.
Copyright (c) Microsoft Corporation. All rights reserved.
THIS SAMPLE CODE AND INFORMATION IS PROVIDED "AS IS" WITHOUT WARR
OF ANY KIND,WHETHER EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMIT
THE IMPLIED WARRANTIES OF MERCHANTABILITY AND/OR FITNESS FOR A PA
PURPOSE. IF THIS CODE AND INFORMATION IS MODIFIED, THE ENTIRE RIS
OR RESULTS IN CONNECTION WITH THE USE OF THIS CODE AND INFORMATIO
REMAINS WITH THE USER.
*****************************************************************
<Configuration>
<ViewDefinitions>
```

The first line and last two lines are essential for making your file. Start up a new file in VS Code right now and copy and paste those three lines at the top of the new file. Save the new file in the same folder as your .psm1 file (assuming you're following along with us). Name it TestViews.format.ps1xml. Saving it will cue VS Code to provide the correct syntax coloring for XML, which is what this is. Go ahead and finish the file by closing those two opening tags:

```
<?xml version="1.0" encoding="utf-8" ?>
<Configuration>
<ViewDefinitions>
</ViewDefinitions>
</Configuration>
```

Everything in XML comes in paired sets of *tags*, and each pair needs to be nested within another pair. The opening `<?xml ?>` bit isn't a tag; it's a document definition, so there's only one of those.

Everything else in the file consists of `<View></View>` sections. Each of these is a *view*, as the tag name implies, and defines a single way of displaying a single kind of object. Here's one as an example:

```
<View>
<Name>System.CodeDom.Compiler.CompilerError</Name>       #A
<ViewSelectedBy>                                                #B
<TypeName>System.CodeDom.Compiler.CompilerError</TypeName>
</ViewSelectedBy>
<ListControl>                           #C
<ListEntries>
<ListEntry>
<ListItems>                   #D
<ListItem>
<PropertyName>ErrorText</PropertyName>
</ListItem>
<ListItem>
<PropertyName>Line</PropertyName>
</ListItem>
<ListItem>
<PropertyName>Column</PropertyName>
</ListItem>
<ListItem>
<PropertyName>ErrorNumber</PropertyName>
</ListItem>
<ListItem>
<PropertyName>LineSource</PropertyName>
</ListItem>
</ListItems>
</ListEntry>
</ListEntries>
</ListControl>
</View>
```

Let's break this down:

- The View has a name. These are often object type names, but that's not required. Frankly, the idea of views having a name you could refer to never played out. The idea was that a single object type could have multiple view options, and that using the `Format-` commands, you could tell PowerShell which one to use. But there's no way to list them all, and the idea never went anywhere.
- A particular object type name selects the View. This is important! Right now, the command is producing objects of the type

`System.PSCustomObject`. That's a commonly used type, and it's not unique to this command—which is a problem. You can only make a view if your command produces an object having a unique type. You'll have to fix this in your command.

- This example shows a list-type view as opposed to a table-type view.
- The list view consists of list entries, and each entry includes a list item. In this example, they specify the property names to display in the list.

TRY IT NOW

Scroll through the file and examine some of the other types of views and other elements—besides property names—that they include. Notice that table controls in particular, are more complex, including an entire section just for the column headers, followed by sections for what those columns will contain.

24.2.2 Adding a custom type name to output objects

You know you need to modify the code. The following listing shows that change.

Listing 24.2 Adding a custom type name to an object

```
function Get-DiskInfo {
 foreach ($domain in (Get-ADForest).domains) {
   $hosts = Get-ADDomainController -filter * -server $domain |
   Sort-Object -Prop hostname
   ForEach ($host in $hosts) {
    $cs = Get-CimInstance -ClassName Win32_ComputerSystem -Comput
    $props = @{'ComputerName' = $host
               'DomainController' = $host
               'Manufacturer' = $cs.manufacturer
               'Model' = $cs.model
               'TotalPhysicalMemory(GB)'=$cs.totalphysicalmemory
               }
     $obj = New-Object -Type PSObject -Prop $props             #A
     $obj.psobject.typenames.insert(0,'Toolmaking.DiskInfo')    #
     Write-Output $obj
   } #foreach $host
  } #foreach $domain
} #function
```

```
Export-ModuleMember -function Get-DiskInfo
```

This isn't a major change: You saved the output object into a variable, `$obj`, rather than immediately emitting it to the pipeline. You then insert a type name, `Toolmaking .DiskInfo`, and place the object into the pipeline. The new type name will replace the original generic type name.

Selecting a type name

.NET Framework's type-naming conventions are designed to make each type name universally unique. You wouldn't want to add a custom type name like "System .DiskInfo", because, for all you know, it either already exists or could exist in the future. `System` is considered a *namespace*, and it's "owned" by Microsoft. Everything starting with `System.` is under Microsoft control, and you shouldn't intrude into the company's playground.

We essentially defined a new `Toolmaking` namespace, under which we have free reign to create whatever we want—and you should do the same, perhaps using a form of your organization's name as the top-level namespace. If you work in IT operations and are specifically on the Storage team, maybe you'd select `MyCompany.ITOps.Storage.DiskInfo` as your custom type name in this example. The idea is to create a hierarchy that allows individual groups to have complete control over their own namespace without fear of overlapping each other.

24.2.3 Creating a new view file

The next listing shows the start of the new view file. Notice that we found a table view we like the look of to use as a starting point.

Listing 24.3 Starting a new view file

```
<?xml version="1.0" encoding="utf-8" ?>
<Configuration>
<ViewDefinitions>
<View>
<Name>System.Reflection.Assembly</Name>
<ViewSelectedBy>
<TypeName>System.Reflection.Assembly</TypeName>
```

```
</ViewSelectedBy>
<TableControl>                                                     #A
<TableHeaders>
<TableColumnHeader>                #B
<Label>GAC</Label>
<Width>6</Width>
</TableColumnHeader>
<TableColumnHeader>
<Label>Version</Label>
<Width>14</Width>
</TableColumnHeader>
<TableColumnHeader/>               #C
</TableHeaders>
<TableRowEntries>              #D
<TableRowEntry>
<TableColumnItems>
<TableColumnItem>
<PropertyName>GlobalAssemblyCache</PropertyName>
</TableColumnItem>
<TableColumnItem>
<PropertyName>ImageRuntimeVersion</PropertyName>
</TableColumnItem>
<TableColumnItem>
<PropertyName>Location</PropertyName>
</TableColumnItem>
</TableColumnItems>
</TableRowEntry>
</TableRowEntries>
</TableControl>
</View>
</ViewDefinitions>
</Configuration>
```

You have some work to do, like adding the custom type name and arranging the table the way you like. But we want to call your attention to this line in particular:

```
<TableColumnHeader/>
```

This is a sneaky XML thing that Microsoft often uses, and it'll mess you up. Remember how we said that XML elements come in pairs? Well, not always. This *singleton* tag both opens and closes itself—that's what the slash at the end means. It's exactly the same as

```
<TableColumnHeader>
```

```
</TableColumnHeader>
```

Go count the number of table column headers in the file right now. It would help if you came up with three. *The number of table column entries must match!* If they don't, the View won't load into the shell. Those singleton tags, however, can be super easy to miss when you're copying and pasting, resulting in a broken formatting file. So, watch for them. They essentially mean, "I want a column here, but I don't want to specify anything for the header—just use the underlying property name, and figure out the width on your own, thanks." Here's the finalized file.

Listing 24.4 Final view file

```
<?xml version="1.0" encoding="utf-8" ?>
<Configuration>
<ViewDefinitions>
<View>
<Name>DiskInfo</Name>              #A
<ViewSelectedBy>
<TypeName>Toolmaking.DiskInfo</TypeName>       #B
</ViewSelectedBy>
<TableControl>
<TableHeaders>             #C
<TableColumnHeader>
<Label>Host</Label>
<Width>16</Width>
</TableColumnHeader>
<TableColumnHeader>
<Label>DC</Label>
<Width>16</Width>
</TableColumnHeader>
<TableColumnHeader>
<Label>Model</Label>
</TableColumnHeader>
<TableColumnHeader>
<Label>RAM</Label>
<Alignment>Right</Alignment>        #D
</TableColumnHeader>
</TableHeaders>
<TableRowEntries>
<TableRowEntry>                     #E
<TableColumnItems>
<TableColumnItem>
<PropertyName>ComputerName</PropertyName>
```

```
</TableColumnItem>
<TableColumnItem>
<PropertyName>DomainController</PropertyName>
</TableColumnItem>
<TableColumnItem>
<PropertyName>Model</PropertyName>
</TableColumnItem>
<TableColumnItem>
<PropertyName>TotalPhysicalMemory(GB)</PropertyName>
</TableColumnItem>
</TableColumnItems>
</TableRowEntry>
</TableRowEntries>
</TableControl>
</View>
</ViewDefinitions>
</Configuration>
```

We’ve made liberal use of carriage returns to make the sections easier to perceive, but there’s still some unintentional word-wrapping happening in the book. We suggest opening the XML file in a text editor or VS Code to review it. Some notes

- You provide a name (which must only be unique *for each type name*; it’s fine if there’s a view with this same name *for another type*) and the custom type name.
- You can ensure the same number of column headers and entries by not using those annoying singleton tags.
- You specify a right alignment for the numeric RAM column.
- The column headers don’t match the underlying property names. That’s because the property names are too darn long—there’s no way you can make a great-looking display with those long names.

The big takeaway here is that *we didn’t do a good job of designing the tool*. Look at that property—`TotalPhysicalMemory(GB)`. That’s horrible. We only did that so the default output of the tool would *look nice*, and we shouldn’t have cared. What we’ve done is make an awkward-looking, difficult-to-refer-to property that will be difficult to type *forever*.

Let’s change the code. Listing 24.5 includes the new code, and listing 24.6 shows the revised view file to go with it. This was designed explicitly to

illustrate why it's a bad idea to worry about appearance from inside a tool, and the importance of fixing mistakes like these when you realize you've made them.

Listing 24.5 Revised tool code

```
function Get-DiskInfo {
 foreach ($domain in (Get-ADForest).domains) {
   $hosts = Get-ADDomainController -filter * -server $domain |
   Sort-Object -Prop hostname
   ForEach ($host in $hosts) {
    $cs = Get-CimInstance -ClassName Win32_ComputerSystem -Comput
    $props = @{'ComputerName' = $host
               'DomainController' = $host
               'Manufacturer' = $cs.manufacturer
               'Model' = $cs.model
               'TotalPhysicalMemory'=$cs.totalphysicalmemory / 1G
               }
     $obj = New-Object -Type PSObject -Prop $props
     $obj.psobject.typenames.insert(0,'Toolmaking.DiskInfo')
     Write-Output $obj
   } #foreach $host
  } #foreach $domain
} #function
Export-ModuleMember -function Get-DiskInfo
```

Listing 24.6 Revised view

```
<?xml version="1.0" encoding="utf-8" ?>
<Configuration>
<ViewDefinitions>
<View>
<Name>DiskInfo</Name>
<ViewSelectedBy>
<TypeName>Toolmaking.DiskInfo</TypeName>
</ViewSelectedBy>
<TableControl>
<TableHeaders>
<TableColumnHeader>
<Label>Host</Label>
<Width>16</Width>
</TableColumnHeader>
<TableColumnHeader>
<Label>DC</Label>
<Width>16</Width>
```

```
</TableColumnHeader>
<TableColumnHeader>
<Label>Model</Label>
</TableColumnHeader>
<TableColumnHeader>
<Label>RAM</Label>
<Alignment>Right</Alignment>
</TableColumnHeader>
</TableHeaders>
<TableRowEntries>
<TableRowEntry>
<TableColumnItems>
<TableColumnItem>
<PropertyName>ComputerName</PropertyName>
</TableColumnItem>
<TableColumnItem>
<PropertyName>DomainController</PropertyName>
</TableColumnItem>
<TableColumnItem>
<PropertyName>Model</PropertyName>
</TableColumnItem>
<TableColumnItem>
<PropertyName>TotalPhysicalMemory</PropertyName>
</TableColumnItem>
</TableColumnItems>
</TableRowEntry>
</TableRowEntries>
</TableControl>
</View>
</ViewDefinitions>
</Configuration>
```

That feels much better!

24.2.4 Adding the view file to a module

You've already saved the view file in the same folder as your module's .psm1 file. But that won't magically tell PowerShell to *use* the view file. Instead, you need to create a module manifest, just as you've done previously, and save it as Test.psd1 (because Test is the name of the module). When creating the manifest, you need to specify the format view. Or, if you've already created a manifest, you can add the format view to it. Let's take the latter approach, so you can see how it's done. Run this command:

```
new-modulemanifest -Path test.psd1 -RootModule test.psm1
```

This creates the .psd1 file but doesn't specify the View. Open it, and edit it as shown in the following listing.

Listing 24.7 Completed module manifest

```
#
# Module manifest for module 'test'
#
# Generated by: User
#
# Generated on: 6/19/2017
#
@{
# Script module or binary module file associated with this manife
RootModule = 'test.psm1'
# Version number of this module.
ModuleVersion = '1.0'
# Supported PSEditions
# CompatiblePSEditions = @()
# ID used to uniquely identify this module
GUID = '3308cc98-f832-4389-93d1-2df122c70a19'
# Author of this module
Author = 'User'
# Company or vendor of this module
CompanyName = 'Unknown'
# Copyright statement for this module
Copyright = '(c) 2017 User. All rights reserved.'
# Description of the functionality provided by this module
# Description = ''
# Minimum version of the Windows PowerShell engine required by th
# PowerShellVersion = ''
# Name of the Windows PowerShell host required by this module
# PowerShellHostName = ''
# Minimum version of the Windows PowerShell host required by this
# PowerShellHostVersion = ''
# Minimum version of Microsoft .NET Framework required by this mo
# DotNetFrameworkVersion = ''
# Minimum version of the common language runtime (CLR) required b
# CLRVersion = ''
# Processor architecture (None, X86, Amd64) required by this modu
# ProcessorArchitecture = ''
# Modules that must be imported into the global environment prior
# RequiredModules = @()
# Assemblies that must be loaded prior to importing this module
```

```
# RequiredAssemblies = @()
# Script files (.ps1) that are run in the caller's environment pr
# ScriptsToProcess = @()
# Type files (.ps1xml) to be loaded when importing this module
# TypesToProcess = @()
# Format files (.ps1xml) to be loaded when importing this module
FormatsToProcess = @('./TestView.format.ps1xml')
# Modules to import as nested modules of the module specified in
# NestedModules = @()
# Functions to export from this module, for best performance, do
FunctionsToExport = '*'
# Cmdlets to export from this module, for best performance, do no
CmdletsToExport = '*'
# Variables to export from this module
VariablesToExport = '*'
# Aliases to export from this module, for best performance, do no
AliasesToExport = '*'
# DSC resources to export from this module
# DscResourcesToExport = @()
# List of all modules packaged with this module
# ModuleList = @()
# List of all files packaged with this module
# FileList = @()
# Private data to pass to the module specified in RootModule/Modu
PrivateData = @{
    PSData = @{
        # Tags applied to this module. These help with module dis
        # Tags = @()
        # A URL to the license for this module.
        # LicenseUri = ''
        # A URL to the main website for this project.
        # ProjectUri = ''
        # A URL to an icon representing this module.
        # IconUri = ''
        # ReleaseNotes of this module
        # ReleaseNotes = ''
    } # End of PSData hashtable
} # End of PrivateData hashtable
# HelpInfo URI of this module
# HelpInfoURI = ''
# Default prefix for commands exported from this module. Override
# DefaultCommandPrefix = ''
}
```

If you’re having trouble spotting it, this is all we changed:

```
# Format files (.ps1xml) to be loaded when importing this module
```

```
FormatsToProcess = @('./TestView.format.ps1xml')
```

We uncommented the `FormatsToProcess` line and added the `TestView.format.ps1xml` file, which—based on this—is in the same folder as the .psd1 and .psm1 files. With everything in place, you should be able to run the command and see the new view as its default output:

```
PS C:\> get-diskinfo
Host             DC               Model
----             --               -----
SRV1              SRV1              Virtual Machine          1.99
```

24.3 Your turn

We want to give you a chance to run through this on your own. We'll provide you with a tool and then ask you to make a custom view for it.

24.3.1 Start here

The next listing shows a PowerShell tool. This should work fine (and should look familiar, because we used it earlier); you need to create a custom view for it. That'll also mean saving it as a module.

Listing 24.8 Starting-point script

```
function Get-MachineInfo {
    [CmdletBinding()]
    Param(
        [Parameter(ValueFromPipeline=$True,
                   Mandatory=$True)]
        [Alias('CN','MachineName','Name')]
        [string[]]$ComputerName,
        [ValidateSet('Wsman','Dcom')]
        [string]$Protocol = "Wsman"
    )
 BEGIN {}
 PROCESS {
    foreach ($computer in $computername) {
        # Establish session protocol
        if ($protocol -eq 'Dcom') {
            $option = New-CimSessionOption -Protocol Dcom
        } else {
```

```
            $option = New-CimSessionOption -Protocol Wsman
        }
        # Connect session
        $session = New-CimSession -ComputerName $computer `
                                  -SessionOption $option
        # Query data
        $os_params = @{'ClassName'='Win32_OperatingSystem'
                       'CimSession'=$session}
        $os = Get-CimInstance @os_params
        $cs_params = @{'ClassName'='Win32_ComputerSystem'
                       'CimSession'=$session}
        $cs = Get-CimInstance @cs_params
        $sysdrive = $os.SystemDrive
        $drive_params = @{'ClassName'='Win32_LogicalDisk'
                          'Filter'="DeviceId='$sysdrive'"
                          'CimSession'=$session}
        $drive = Get-CimInstance @drive_params
        $proc_params = @{'ClassName'='Win32_Processor'
                         'CimSession'=$session}
        $proc = Get-CimInstance @proc_params |
                Select-Object -first 1
        # Close session
        $session | Remove-CimSession
        # Output data
        $props = @{'ComputerName'=$computer
                   'OSVersion'=$os.version
                   'SPVersion'=$os.servicepackmajorversion
                   'OSBuild'=$os.buildnumber
                   'Manufacturer'=$cs.manufacturer
                   'Model'=$cs.model
                   'Procs'=$cs.numberofprocessors
                   'Cores'=$cs.numberoflogicalprocessors
                   'RAM'=($cs.totalphysicalmemory / 1GB)
                   'Arch'=$proc.addresswidth
                   'SysDriveFreeSpace'=$drive.freespace}
        $obj = New-Object -TypeName PSObject -Property $props
        Write-Output $obj
    } #foreach
} #PROCESS
END {}
} #function
```

24.3.2 Your task

We want your custom view to include five columns: ComputerName, OSVersion, Model, Cores, and RAM. Use the original property names for all

columns, rather than making up different column headers.

24.3.3 Our take

Listing 24.9 shows our modified tool—we needed to add the custom type name.

Listing 24.9 Modified .psm1 file

```
function Get-MachineInfo {
    [CmdletBinding()]
    Param(
        [Parameter(ValueFromPipeline=$True,
                   Mandatory=$True)]
        [Alias('CN','MachineName','Name')]
        [string[]]$ComputerName,
        [ValidateSet('Wsman','Dcom')]
        [string]$Protocol = "Wsman"
    )
 BEGIN {}
 PROCESS {
    foreach ($computer in $computername) {
        # Establish session protocol
        if ($protocol -eq 'Dcom') {
            $option = New-CimSessionOption -Protocol Dcom
        } else {
            $option = New-CimSessionOption -Protocol Wsman
        }
        # Connect session
        $session = New-CimSession -ComputerName $computer `
                                  -SessionOption $option
        # Query data
        $os_params = @{'ClassName'='Win32_OperatingSystem'
                       'CimSession'=$session}
        $os = Get-CimInstance @os_params
        $cs_params = @{'ClassName'='Win32_ComputerSystem'
                       'CimSession'=$session}
        $cs = Get-CimInstance @cs_params
        $sysdrive = $os.SystemDrive
        $drive_params = @{'ClassName'='Win32_LogicalDisk'
                          'Filter'="DeviceId='$sysdrive'"
                          'CimSession'=$session}
        $drive = Get-CimInstance @drive_params
        $proc_params = @{'ClassName'='Win32_Processor'
                         'CimSession'=$session}
```

```
        $proc = Get-CimInstance @proc_params |
                Select-Object -first 1
        # Close session
        $session | Remove-CimSession
        # Output data
        $props = @{'ComputerName'=$computer
                   'OSVersion'=$os.version
                   'SPVersion'=$os.servicepackmajorversion
                   'OSBuild'=$os.buildnumber
                   'Manufacturer'=$cs.manufacturer
                   'Model'=$cs.model
                   'Procs'=$cs.numberofprocessors
                   'Cores'=$cs.numberoflogicalprocessors
                   'RAM'=($cs.totalphysicalmemory / 1GB)
                   'Arch'=$proc.addresswidth
                   'SysDriveFreeSpace'=$drive.freespace}
        $obj = New-Object -TypeName PSObject -Property $props
        $obj.psobject.typenames.insert('Toolmaking.MachineInfo')
        Write-Output $obj
    } #foreach
} #PROCESS
END {}
} #function
```

Listing 24.10 shows our view file. Because we wanted to use property names as column headers, we could have resorted to the singleton tag trick for most of these (we wanted Cores and RAM right-aligned, so we needed the full tags). But those singletons have messed us up so many times that we felt better about making each column header a full tag pair.

Listing 24.10 Our new .format.ps1xml file

```
<?xml version="1.0" encoding="utf-8" ?>
<Configuration>
<ViewDefinitions>
<View>
<Name>MachineInfo</Name>
<ViewSelectedBy>
<TypeName>Toolmaking.MachineInfo</TypeName>
</ViewSelectedBy>
<TableControl>
<TableHeaders>
<TableColumnHeader>
<Label>ComputerName</Label>
</TableColumnHeader>
```

```
<TableColumnHeader>
<Label>OSVersion</Label>
</TableColumnHeader>
<TableColumnHeader>
<Label>Model</Label>
</TableColumnHeader>
<TableColumnHeader>
<Label>Cores</Label>
<Alignment>Right</Alignment>
</TableColumnHeader>
<TableColumnHeader>
<Label>RAM</Label>
<Alignment>Right</Alignment>
</TableColumnHeader>
</TableHeaders>
<TableRowEntries>
<TableRowEntry>
<TableColumnItems>
<TableColumnItem>
<PropertyName>ComputerName</PropertyName>
</TableColumnItem>
<TableColumnItem>
<PropertyName>OSVersion</PropertyName>
</TableColumnItem>
<TableColumnItem>
<PropertyName>Model</PropertyName>
</TableColumnItem>
<TableColumnItem>
<PropertyName>Cores</PropertyName>
</TableColumnItem>
<TableColumnItem>
<PropertyName>RAM</PropertyName>
</TableColumnItem>
</TableColumnItems>
</TableRowEntry>
</TableRowEntries>
</TableControl>
</View>
</ViewDefinitions>
</Configuration>
```

Listing 24.11 shows our manifest file for the module.

Listing 24.11 Our new .psd1 file

```
#
```

```
# Module manifest for module 'test'
#
# Generated by: User
#
# Generated on: 6/19/2017
#
@{
# Script module or binary module file associated with this manife
RootModule = 'test.psm1'
# Version number of this module.
ModuleVersion = '1.0'
# Supported PSEditions
# CompatiblePSEditions = @()
# ID used to uniquely identify this module
GUID = '3308cc98-f832-4389-93d1-2df122c70a19'
# Author of this module
Author = 'User'
# Company or vendor of this module
CompanyName = 'Unknown'
# Copyright statement for this module
Copyright = '(c) 2017 User. All rights reserved.'
# Description of the functionality provided by this module
# Description = ''
# Minimum version of the Windows PowerShell engine required by th
# PowerShellVersion = ''
# Name of the Windows PowerShell host required by this module
# PowerShellHostName = ''
# Minimum version of the Windows PowerShell host required by this
# PowerShellHostVersion = ''
# Minimum version of Microsoft .NET Framework required by this mo
# DotNetFrameworkVersion = ''
# Minimum version of the common language runtime (CLR) required b
# CLRVersion = ''
# Processor architecture (None, X86, Amd64) required by this modu
# ProcessorArchitecture = ''
# Modules that must be imported into the global environment prior
# RequiredModules = @()
# Assemblies that must be loaded prior to importing this module
# RequiredAssemblies = @()
# Script files (.ps1) that are run in the caller's environment pr
# ScriptsToProcess = @()
# Type files (.ps1xml) to be loaded when importing this module
# TypesToProcess = @()
# Format files (.ps1xml) to be loaded when importing this module
FormatsToProcess = @('./TestView.format.ps1xml')
# Modules to import as nested modules of the module specified in
# NestedModules = @()
```

```
# Functions to export from this module, for best performance, do
FunctionsToExport = '*'
# Cmdlets to export from this module, for best performance, do no
CmdletsToExport = '*'
# Variables to export from this module
VariablesToExport = '*'
# Aliases to export from this module, for best performance, do no
AliasesToExport = '*'
# DSC resources to export from this module
# DscResourcesToExport = @()
# List of all modules packaged with this module
# ModuleList = @()
# List of all files packaged with this module
# FileList = @()
# Private data to pass to the module specified in RootModule/Modu
PrivateData = @{
    PSData = @{
        # Tags applied to this module. These help with module dis
        # Tags = @()
        # A URL to the license for this module.
        # LicenseUri = ''
        # A URL to the main website for this project.
        # ProjectUri = ''
        # A URL to an icon representing this module.
        # IconUri = ''
        # ReleaseNotes of this module
        # ReleaseNotes = ''
    } # End of PSData hashtable
} # End of PrivateData hashtable
# HelpInfo URI of this module
# HelpInfoURI = ''
# Default prefix for commands exported from this module. Override
# DefaultCommandPrefix = ''
}
```

25 Wrapping up the .NET Framework

As you begin exploring the possibilities of what PowerShell can achieve, you'll inevitably encounter situations where there's no prebuilt cmdlet to perform your desired task. In many instances, you may find that the extensive .NET Framework, or possibly an external command, an old COM object, or something else, can address your needs. Can you use raw .NET components in your scripts? The answer is not a straightforward "no," but not a definitive "yes."

25.1 Why PowerShell Exists?

To understand this better, let's reflect on why PowerShell exists in the first place. Microsoft Windows, as an operating system, offers an abundance of tools designed to facilitate automation. It's inherent to the nature of computers. The challenge with Windows has always been that these automation capabilities are tailored for professional software developers and may not be user-friendly for administrators without extensive programming expertise or those pressed for time.

You could automate Windows effectively if you were well-versed in languages like C++, C#, and other first-class Windows programming languages. However, you faced difficulties if you lacked this knowledge or the time to delve into these lower-level languages or their APIs.

PowerShell didn't come into being to introduce new automation capabilities to Windows. Instead, it aimed to provide an administrator-friendly means of leveraging what already existed. When you run a PowerShell cmdlet like Get-Process, you're not executing brand-new code invented by someone at Microsoft. Inside that cmdlet, you'll find fundamental .NET Framework references coded in C#. In essence, a C# developer acted as a translator for you. You run a PowerShell cmdlet, and it's translated into the C# and .NET

Framework understood by Windows.

In essence, PowerShell is a translator—a wrapper. PowerShell cmdlets wrap around .NET Framework, CIM, COM, and other Windows APIs. This approach delivers a more consistent user experience: cmdlet names follow a uniform naming convention, they accept input via parameters, and so on. You don't need to be familiar with the thousands of Windows APIs or the half-dozen languages required to access them. PowerShell translates for you, all thanks to the work of the developers who crafted PowerShell's cmdlets.

So, is using raw .NET Framework components in your scripts permissible? In their raw form, no. What's acceptable, however, is performing a developer's work by creating your wrappers for that .NET functionality. Instead of integrating arbitrary, C#-like .NET code into your script, craft your cmdlets to make .NET appear as a typical PowerShell command. This is what we'll explore in this chapter.

Note

This topic has become less frequent over the years because Microsoft has been diligent in creating numerous cmdlets. In the past, we often used DNS as an example, but today, we have an array of DNS-specific PowerShell cmdlets. Please bear with us if our example may appear somewhat light or not entirely real-world. Our aim is to impart the process and pattern of building custom PowerShell cmdlets, which remains as relevant as ever.A crash course in .NET

25.1.1 A Crash Course in .Net

If you're going to use .NET, you have to know some of the lingo. Otherwise, the docs make no sense:

- A *type* is a definition of a software thing. You see this word in PowerShell all the time—whenever you run `Get-Member`, for example, you see the *type name* of whatever you piped to `Get-Member`.
- A *class* is a kind of type. That is, a class is a definition for a piece of functioning software. The class describes how you can interact with the

software, but it's just a definition. For example, `System.Diagnostics.Process` is the type name for a class that describes running processes on Windows.

- An *instance* is a concrete implementation of a class. For example, the lsass process is represented by an instance of `System.Diagnostics.Process`. In most cases, you need to have an *instance* of a class in order to interact with it. You can't terminate a process, for example, unless you have a specific one to terminate.
- Some classes are *abstract*, meaning you don't need a concrete instance in order to interact. For example, the `Math` class in .NET is abstract, meaning you don't have to *instantiate* the class in order to do things like calculate tangents and cosines.
- Classes consist of *members*. These are the things that make up the definition that is the class, and it's where `Get-Member` takes its name from. There are some common kinds of members:
    - *Properties* describe whatever the class represents, like a process name or a service status. Sometimes, properties are read-only; other times, you can change them. For example, you might be able to change a service name, but you can't modify the `Status` property to change whether the service is running.
    - *Methods* take actions. A method might terminate a process or start a service. Sometimes, methods take *arguments*, which are like command parameters. Restarting a computer might let you specify a forced restart or a power-off, for example.
    - *Events* are triggered when something happens to an instance, such as a service completing its startup. Although PowerShell isn't great at event-driven coding, you can sort of subscribe to an event, giving you an opportunity to execute code when the event occurs.

The first big question people ask us about working with .NET is, "How do I find the bit of .NET that will do what I need?" This is a bit like asking, "Who in the government can make such-and-such happen?" We dunno. We use Google a lot. Look, .NET is huge. Vastly huge. You may think it's a huge distance down the road to your grocery store, but that's peanuts compared to .NET. And half the stuff Microsoft sells *adds* to .NET. So, yeah. Google.

Once you think you've found the bit of .NET you want, you'll usually find its

documentation on Microsoft’s website, generally by following a Google query for the class name. For example, plug in `System.Diagnostics.Process`, and you’ll find a page like https://msdn.microsoft.com/en-us/library/system.diagnostics.process(v=vs.110).aspx. Those pages are version-specific, so you have to make sure you’re selecting (from the drop-down at the top of the page) the right .NET Framework version. Also, that URL will probably cease to exist the minute this book hits paper—Microsoft is like that. That’s why we Google.

25.2 Exploring a Class

PowerShell's versatility shines in its ability to function as an immediate window for .NET, enabling you to experiment with .NET code in real time. Let's delve into some practical examples.

For instance, you can use the Math class from .NET for mathematical operations:

```
[Math]::Abs(-5)
```

TRY IT NOW

Go ahead and try this on your workstation.

This example uses the `Math` class from .NET, which consists entirely of static members:

- The `[]`square brackets are PowerShell’s convention for identifying types. By putting a type name in these brackets, you’re telling PowerShell to look up the corresponding type—in this case, a class—in .NET. This is exactly the same as declaring a variable as a `[string]`—in that case, you’re referring to the `System .String` class.
- The `::` double colons are used to refer to static members of a class. These are always used with a `[classname]`, because you’re not instantiating the class. In other words, you wouldn’t use double colons with an instance that’s been stored in a variable (as in,

`$myobject::method`).

- `Abs()` is a static method of the `Math` class, which we looked up in MSDN. It returns the absolute value of whatever input you provide.

Let's do something a little more complex—and a little more fun. Thanks to Mark Minasi for this suggestion: making your computer talk to you. Make sure your audio is turned on and turned up to 11 for this one, and definitely follow along.

We Googled ".NET speech synthesis" and found ourselves at https://msdn.microsoft.com/en-us/library/system.speech.synthesis(v=vs.110).aspx. The `System.Speech.Synthesis` *namespace* is documented there. In other words, `System.Speech.Synthesis` isn't the name of a type (meaning it isn't the name of a class). Instead, it's the top-level portion of the name of several types (including classes). The top part of the documentation page lists the classes that fall under this namespace. Other types include *enumerations*, which are basically structures that define various allowable input arguments (and assign easier-to-remember names, rather than numbers, to those arguments). The remarks toward the end of the page provide some basic overviews of how to use the classes in this namespace.

The remarks seem to indicate that `System.Speech.Synthesis.SpeechSynthesizer` is the class we want to play with, so we'll click through to https://msdn.microsoft.com/en-us/library/system.speech.synthesis.speechsynthesizer(v=vs.110).aspx, the documentation page for that.

Note

Remember, Microsoft sometimes reorganizes their documentation, so if these URLs don't work, don't panic! Google for the class name, and you'll get to wherever the docs are at the time.

Of particular interest is that none of the methods—remember, methods do things, and we want to do something, so we're looking at methods—are static. We can tell, because none of them have the little *S* icon that Microsoft uses to denote static members. Lacking any static methods, we'll need to

instantiate the class to create a concrete instance that will provide access to methods. Instantiating a class requires us to use a special kind of method called a *constructor*, which constructs the instance. Many classes have many constructors, which often accept input arguments to tell the new instance how to build itself. In this case, the class is only listed with one constructor, and it has no input arguments, so this should be easy:

```
PS C:\> $talk = new-object system.speech.synthesis.speechsynthesi
new-object : Cannot find type
[system.speech.synthesis.speechsynthesizer]: verify that the
assembly containing this type is loaded.
At line:1 char:9
+ $talk = new-object system.speech.synthesis.speechsynthesizer
+         ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
    + CategoryInfo          : InvalidType: (:) [New-Object], PSAr
   entException
    + FullyQualifiedErrorId : TypeNotFound,Microsoft.PowerShell.C
   ands.NewObjectCommand
```

Well, crud. Not so easy. We're guessing that PowerShell probably doesn't load the `Speech` portion of the `System` namespace automatically. Why would it? We probably have to manually load that assembly to get that part of .NET into memory. The top of the documentation says that the assembly is System.Speech.dll:

```
PS C:\> Add-Type -AssemblyName System.Speech
PS C:\> $talk = new-object system.speech.synthesis.speechsynthesi
```

It's important to specify the `–AssemblyName` parameter and to omit the .dll filename extension. This should work for any core part of .NET that's part of the Global Assembly Cache (GAC); .NET knows how to find the correct physical file. And, as you can see, we now have a `$talk` variable with our `SpeechSynthesizer` instance. Let's make it talk.

The docs list a few `Speak()` methods, each of which accepts a different type of input argument. These are called *overloads*. In .NET, you can have multiple methods with the same name, as long as each one accepts a unique combination of input arguments. It looks like one overload accepts a string, so we should be able to run this:

```
PS C:\> $talk.speak('PowerShell to the rescue!')
```

Huzzah! It worked! From here, we can start playing around with other methods and properties of the instance to see what they do.

25.3 Making a wrapper

We’re not finished. Remember, this .NET stuff is ugly—we want to make it PowerShell Pretty. So, let’s write a wrapper. Check out the following listing, which includes a call to the new function so we can test it.

Listing 25.1 Wrapper for the speech synthesizer

```
function Invoke-Speech {
    [CmdletBinding()]
    Param(
        [Parameter(Mandatory=$true,
                   ValueFromPipeline=$true)]           #A
        [string[]]$Text
    )
    BEGIN {
        Add-Type -AssemblyName System.Speech        #B
        $speech = New-Object -TypeName System.Speech.Synthesis.Sp
    }
    PROCESS {
        foreach ($phrase in $text) {
            $speech.speak($phrase)
        }
    }
    END {}
}
"One","Two","Three" | Invoke-Speech
```

We want to call out a few items:

- We’ve tried to stick with native PowerShell patterns as much as possible. The function accepts pipeline input, for example, and we use that technique in the test call.
- In pipeline mode, there’s no reason to repeatedly add the assembly and instantiate the synthesizer, so that’s done in a Begin block.
- When `$speech` goes out of scope, the synthesizer will cease to exist automatically, so there’s no need to remove the object in the End block. Similarly, we don’t feel the need to unload the assembly (it’s not hurting

anything or taking up memory), so we don't do so.

This isn't ideal, though. In playing with the speech object, we noticed that it has a `Speak()` method for *synchronous* speech—meaning the script will pause while the speech happens—and a `SpeakAsync()` method, which will fire off the speaking and allow the script to continue. We can see uses for both models, so we'd like to include those as options for someone using our wrapper command. Here's the new code.

Listing 25.2 Adding `SpeakAsync()` support

```
function Invoke-Speech {
    [CmdletBinding()]
    Param(
        [Parameter(Mandatory=$true,
                   ValueFromPipeline=$true)]
        [string[]]$Text,
        [switch]$Asynchronous                  #A
    )
    BEGIN {
        Add-Type -AssemblyName System.Speech
        $speech = New-Object -TypeName System.Speech.Synthesis.Sp
    }
    PROCESS {
        foreach ($phrase in $text) {
            if ($Asynchronous) {                 #B
                $speech.SpeakAsync($phrase)
            } else {
                $speech.speak($phrase)           #C
            }
        }
    }
    END {}
}
1..10 | Invoke-Speech -Asynchronous
Write-Host "This appears"
```

"This appears" will be displayed before any of the…uh…other output:

```
This appears
IsCompleted
-----------
      False
      False
```

```
False
False
False
False
False
False
False
False
```

Well, that’s awkward looking. Going back and reading the docs, it appears that `SpeakAsync()` returns an object indicating whether the speech is completed. We don’t care about that, so we need to suppress it. Here’s our final attempt.

Listing 25.3 Suppressing the `SpeakAsync()` output

```
function Invoke-Speech {
    [CmdletBinding()]
    Param(
        [Parameter(Mandatory=$true,
                   ValueFromPipeline=$true)]
        [string[]]$Text,
        [switch]$Asynchronous
    )
    BEGIN {
        Add-Type -AssemblyName System.Speech
        $speech = New-Object -TypeName System.Speech.Synthesis.Sp
    }
    PROCESS {
        foreach ($phrase in $text) {
            if ($Asynchronous) {
                $speech.SpeakAsync($phrase) | Out-Null          #
            } else {
                $speech.speak($phrase)
            }
        }
    }
    END {}
}
1..10 | Invoke-Speech -Asynchronous
Write-Host "This appears"
```

TRY IT NOW

Seriously, give this a run. It’s fun. And then check out [PowerShell Gallery |](#)

Functions/Invoke-Speak.ps1 2.2.8, which is a more complex version of our wrapper that you'll love playing with. Bravo Zulu!

Wrapping this small amount of code may seem like a waste of time, but it isn't—it's an investment. Here are a few of the things you gain:

- Nobody else on your team will need to research this object again—they can use your simple, PowerShell-compliant command. We'd obviously add help to this to make it even more PowerShell-native.
- If you start getting into unit testing with Pester, *you can't mock .NET stuff*—but because you've written a wrapper, you *could* mock calls to `Invoke-Speech`, if you needed to.
- Documentation—if you take the time to produce at least comment-based help—is built-in, rather than requiring a Google search and MSDN spelunking.

25.4 A more practical example

Here's a more practical example, which you might use in a controller script. Let's say you want to provide a graphical input box for your script. We used to do this in VBScript, and the functionality is still available in the VisualBasic part of the .NET Framework. First you need to add the assembly:

```
Add-Type -AssemblyName "microsoft.visualbasic"
```

The `[microsoft.visualbasic.interaction]` class has a static method called `InputBox()` that takes three arguments, in this order: a prompt, a title, and a default choice. Run this code to create the input box shown in figure 25.1:

```
[microsoft.visualbasic.interaction]::inputbox("Enter a server nam
```

Figure 25.1 An input box

The user enters a value and clicks OK, and the value is written to the pipeline. You would, of course, need to add error-handling and validation in case they entered nothing or clicked Cancel. If this were something you wanted to use often, you could create a function around it. For example, we've written a short one in the following listing.

Listing 25.4 Quick and easy `InputBox` wrapper

```
function Invoke-InputBox {
  [CmdletBinding()]
  Param(
    [Parameter(Mandatory=$True)]
    [string]$Prompt,
    [Parameter(Mandatory=$True)]
    [string]$Title,
    [Parameter()]
    [string]$Default = ''
  )
  Add-Type -Assembly Microsoft.VisualBasic
  [microsoft.visualbasic.interaction]::inputbox($prompt,$title,$d
} #function
```

This illustrates how small a wrapper can be and how easy it is to create, and how much easier wrappers can make it for someone else to use .NET.

25.5 Your turn

This is such an important task that we'd like you to give it a try.

25.5.1 Start here

The `System.Net.Dns` class has a static method named `GetHostByAddress()`.

It’s designed to look up a host name, given its IP address. Go on—look it up online, and experiment with it in the shell.

25.5.2 Your task

Write a Get-DnsHostByAddress wrapper function. It should accept one or more IP addresses, and, for each one, emit an object containing the IP address and the corresponding host name. If no host name is available, it should return a null for the hostname.

25.5.3 Our take

Playing with this on the command line, we discovered that the method returns an object with three properties: `HostName`, which is great; `Aliases`, which could be fun; and `AddressList`, which looks to be an array. We decided to keep this simple and focus only on `HostName` in our wrapper.

Listing 25.5 Our wrapper for looking up DNS host names

```
function Get-DnsHostByAddress {
    [CmdletBinding()]
    Param(
        [Parameter(Mandatory=$true,
                   ValueFromPipeline=$true)]
        [string[]]$Address
    )
    BEGIN {}
    PROCESS {
        ForEach ($Addr in $Address) {
            $props = @{'Address'=$addr}
            Try {
                $result = [System.Net.Dns]::GetHostByAddress($add
                $props.Add('HostName',$result.HostName)
            } Catch {
                $props.Add('HostName',$null)
            }
            New-Object -TypeName PSObject -Property $props
        } #foreach
    } #PROCESS
    END {}
} #function
Get-DnsHostByAddress -Address '204.79.197.200','192.168.254.254',
```

There are a few things we'd like you to notice:

- We made sure to test both a legitimate IP address (hi, Bing.com!) as well as a bad one, because we have different output in each situation.
- In normal command error-handling, we'd have to specify an –`ErrorAction` to ensure a trappable exception. .NET methods don't work that way—when they fail, they pretty much always produce a trappable exception, so our `Try` block works perfectly.
- You might prefer to use `Unknown` or some value other than `$null` for failed hosts. We like `$null`, so we used that.
- We started a hash table for our eventual output object's properties right up front. Then, depending on the outcome of the query, we added a `HostName` property. We like this technique—it lets us dynamically construct our output a piece at a time and then push it all out into the pipeline as an object when we're finished.

26 Storing data—not in Excel!

PowerShell offers the capability to generate and modify Excel documents dynamically. Yet just because it's feasible doesn't mean it's the right approach. Excel isn't designed to function as a database, and it's disheartening to witness individuals grappling with it as such. Developing scripts that interact with Excel through PowerShell necessitates the utilization of Microsoft Office Programmability components, which are integrated into .NET when Office is installed. These components, in turn, rely on a Component Object Model (COM) interface that Microsoft hasn't updated in ages.

It's disheartening to observe administrators crafting scripts that involve extensive Excel-related code, resulting in a time-consuming, exasperating, and unproductive experience. We strongly advise against pursuing this approach. However, the need to store data will inevitably arise. In such cases, a more suitable alternative is available.

26.1 Introducing SQL Server!

We're pretty sure you've heard of Microsoft SQL Server. If you have one in your environment, see if you can get a small database set up on it for your use. You won't be loading it with work, and it won't cost a dime. Or, if nothing else, install the free SQL Server Express (the 2016 edition can be found at http://www.microsoft.com/en-us/sql-server/sql-server-editions-express, but you can use whatever version you like as far as this chapter is concerned). We recommend downloading the one with Advanced Services (although the name is slightly different from version to version), which includes Reporting Services. We also recommend downloading SQL Server Management Studio (SSMS); frankly, it's easier to Google "SQL Server Management Studio download" than it is for us to give you a URL, because Microsoft moves that around a good bit.

NOte

We don't want this chapter to get bogged down in teaching you about SQL Server or how to manage it. If you need some place to start, you might take a look at *Learn SQL Server Administration in a Month of Lunches* (Manning, 2014, http://www.manning.com/books/learn-sql-server-administration-in-a-month-of-lunches). Manning has a live video "book" titled *SQL in Motion* by Ben Brumm (2017, www.manning.com/livevideo/sql-in-motion). As well as Learn DBA Tools in a much of lunches

Here are some of the advantages of using SQL Server (or, honestly, any relational database management system—if you prefer one over SQL Server, most of what's in this chapter will still work fine for you):

- Databases make adding, deleting, updating, and query data incredibly easy. *Very* easy.
- SQL Server Reporting Services can then produce beautiful reports, which you design in a friendly, drag-and-drop designer environment. The non-express Reporting Services can run and deliver those reports on a schedule for you.
- PowerShell works *excellent* with SQL Server (and other databases).

You'll need to master a few pieces of terminology and a couple of concepts:

- Of course, you connect to a server, but you also connect to a specific database. There's a particular database called *master* that you connect to when you want to create a new database for yourself.
- The connection is made by specifying a *connection string*, essentially a database's contact location. It also includes authentication information.
- A database consists of *tables*, each of which is roughly analogous to an Excel sheet. Therefore, you can think of a database as an Excel workbook.
- A table consists of *rows* and *columns*, like an Excel sheet. Database geeks sometimes refer to these as *entities* and *domains* as well.

26.2 Setting up everything

Frankly, the one-time server and database setup takes longer to explain and perform than using the dang thing. First, as already stated, we're going to

assume that you've installed SQL Server Express. We're using 2016, and we performed a Basic install (which doesn't prompt for anything else). Subsequent editions won't be much different to install, and you can accept all the defaults if there are any setup prompts. If you're using a SQL Server that's on your network somewhere, have the administrator of it give you the *server name* and, if there is one, the *instance name*.

NOTE

Whatever user account you used to install SQL Server Express will usually be set up as Administrator of the SQL Server Express instance. This is true whether you're in a domain environment or not.

Second, you need a database. If you're using a SQL Server on your network, the administrator must create a database (2 to 3GB is acceptable; advise them that the Simple Recovery model is okay for now). They'll need to give you the database name and let you know whether you can connect using your Windows log-on credentials or if there's a separate username and password for you to use.

If you installed SQL Server Express locally and used all the default settings, then you've installed an instance named SQLEXPRESS. Run the PowerShell script in listing 26.1 to create a new database named Scripting. Use your Windows log-on credentials to connect; the new database will be the default minimum size (usually about 2GB). We should note that this isn't suitable for a production environment because there are several database options you'd typically set, and you'd want to arrange for backups; read *Learn SQL Server Administration in a Month of Lunches* if you'd like to explore those tasks.

Listing 26.1 Setting up a new database on a local SQL Server Express instance

```
$conn_string = "Server=localhost\SQLEXPRESS;Database=master;Trust
$conn = New-Object System.Data.SqlClient.SqlConnection         #B
$conn.ConnectionString = $conn_string                          #C
$conn.Open()
$sql = @"                                    #D
CREATE DATABASE Scripting;
"@
$cmd = New-Object System.Data.SqlClient.SqlCommand          #E
```

```
$cmd.CommandText = $sql                                              #F
$cmd.Connection = $conn                         #G
$cmd.ExecuteNonQuery()      #H
$conn.close()     #I
```

Third, there's no third thing. You'll need a connection string, but you should already have everything you need for it. Ours is this:

```
Server=localhost\SQLEXPRESS;Database=master;Trusted_Connection=Tr
```

As you can see, we used that in the code to create a new database; when we're ready to use that database, we'll change `master` to `Scripting` in the connection string. That same connection string works for any database where you can use your Windows log-on credentials to connect. If, instead, you need to specify a username and password, it will look like this:

```
Server=localhost\SQLEXPRESS;Database=master;un=xxxxx;pw=yyyyyy;
```

where `xxxxx` and `yyyyy` are your SQL Server username and password, respectively.

TIP

We use [ConnectionStrings.com]() to come up with our connection strings. It's an invaluable reference. Why remember that stuff when you can look it up?

26.3 Using your database: creating a table

You first need to decide what you will put in the database. This isn't a one-time decision; just as with Excel, you can add and remove sheets (tables) at any time and modify the columns used in each table at any time. Let's start with the command in listing 26.2. Like most commands we write, this produces objects as output, so it's a perfect starting point (and yes, we've used this particular command before).

TIP

For development and testing purposes, you will save this script as its own script module. You'll add additional commands to this .psm1 file as you go,

keeping everything nicely grouped together.

Listing 26.2 Starting with a command that produces objects as output

```
function Get-DiskInfo {
    [CmdletBinding()]
    Param(
        [Parameter(Mandatory=$True,
                   ValueFromPipeline=$True)]
        [string[]]$ComputerName
    )
    BEGIN {
        Set-StrictMode -Version 2.0
    }
    PROCESS {
        ForEach ($comp in $ComputerName) {
            $params = @{'ComputerName' = $comp
                        'ClassName' = 'Win32_LogicalDisk'}
            $disks = Get-CimInstance @params
            ForEach ($disk in $disks) {
                $props = @{'ComputerName' = $comp
                           'Size' = $disk.size
   'Drive' = $disk.deviceid
                           'FreeSpace' = $disk.freespace
                           'DriveType' = $disk.drivetype}
                New-Object -TypeName PSObject -Property $props
            } #foreach disk
        } #foreach computer
    } #PROCESS
    END {}
}
```

Examining the command, it produces the following:

- *Computer name*—A string
- *Disk size*—A large integer
- *Drive type*—A small (single-digit) integer
- *Disk free space*—A large integer
- *Drive ID*—A string

Therefore, you need to create a table that can contain this information. In addition, you'll add a field to track the date that each row is added to the table. That way, you can periodically inventory drive information and

construct a trend line of free space. (We'd use Reporting Services to produce that trend report; it's beyond the scope of this book to get into report production, but PowerShell.org offers a free eBook on the subject if you'd like to investigate further on your own.) The following listing shows what we're adding to our .psm1 file (the downloadable version of this listing at www.manning.com/books/learn-powershell-scripting-in-a-month-of-lunches is the entire thing; we're saving some space in the book by only showing the additional code here). Most of the code should start looking familiar because we used it earlier.

Listing 26.3 Adding code for table creation

```
function New-DiskInfoSQLTable {
    [CmdletBinding()]
    param()
    $conn = New-Object System.Data.SqlClient.SqlConnection
    $conn.ConnectionString = $DiskInfoSqlConnection
    $conn.Open()
    $sql = @"
        IF NOT EXISTS (SELECT * FROM sysobjects WHERE name='diski
            CREATE TABLE diskinfo (
                ComputerName VARCHAR(64),
                DiskSize BIGINT,
                DriveType TINYINT,
                FreeSpace BIGINT,
                DriveID CHAR(2),
DateAdded DATETIME2
            )
"@
    $cmd = New-Object System.Data.SqlClient.SqlCommand
    $cmd.Connection = $conn
    $cmd.CommandText = $sql
    $cmd.ExecuteNonQuery() | Out-Null
    $conn.Close()
}
$DiskInfoSqlConnection = "Server=localhost\SQLEXPRESS;Database=Sc
Export-ModuleMember -Function Get-DiskInfo
Export-ModuleMember -Variable DiskInfoSqlConnection
```

We want to point out that we've added a module-level variable, *outside* any function, to contain the database connection string. That makes it easier to reuse that information in numerous functions. You explicitly export that variable, along with the first function, so that all will be added to the global

scope of the shell whenever the module is loaded. Similarly, they'll all be neatly removed from the global scope if the module is unloaded. Why don't you export the new table-creation function? Because there's no reason for anyone outside this module to run that, and so by not exporting it, you make it private to this module.

The new command does what we think is a neat trick: It first checks to see whether the table exists. If it doesn't, the command creates the table. This way, you can repeatedly call the new command, and it'll always make sure the table exists.

This is probably a good time to go over the broad process this code uses, because you'll see it again two more times:

1. Create a new `System.Data.SqlClient.SqlConnection` object. This represents the connection to SQL Server. Set its `ConnectionString` property to your connection string, and then call its `Open()` method. If the connection string isn't right, this is where you'll generate an error. You also fill in a call to the `Close()` method at the end of the command.
2. Build the query in a here-string, mainly so that it can be nicely formatted. You use double quotes for the here-string because SQL Server uses single quotes as its string delimiter. Using double quotes makes it easy to use single quotes inside the here-string and allows you to insert variables and subexpressions. Having the query in a variable makes it easy to output it using `Write-Verbose`, so you can double-check the query syntax easily if there's an error.
3. Create a new `System.Data.SqlClient.SqlCommand`, and set its `Connection` property to the opened `Connection` object. Set its `CommandText` property to your query, and ask it to `ExecuteNonQuery()`. That method is used when you know your query won't return any results; it *will* return -1 for a successful query, so you pipe that to `Out-Null` to suppress it.

You'll use these same two objects, in the same way in the upcoming commands.

Note

If you aren't using SQL Server, .NET also includes the equivalent `System.Data.OleDbClient` namespace along with `OleDbConnection` and `OleDbCommand` classes for connecting to other databases.

You may be wondering how we came up with all the data types for the `CREATE TABLE` statement. Simple: we looked them up. Googling "SQL Server data types" took us to https://docs.microsoft.com/en-us/sql/t-sql/data-types/data-types-transact-sql, which was pretty useful. In reality, we find ourselves lazily using just a few data types:

- `VARCHAR()`—This lets you specify a maximum field length and takes up less space if you use less than the max. `VARCHAR(MAX)` enables you to store any amount of text.
- `CHAR()`—Creates fixed-length text columns.
- `TINYINT`—Holds integers from 0 to 255.
- `BIGINT`—Holds pretty much any size integer.
- `DATETIME2`—Holds date/time values.

You may also have use for `FLOAT` or `INT`, and you can read all about them in the SQL documentation.

26.4 Saving data to SQL Server

Now you're ready to make a third command, shown in the next listing, which will accept the output of the disk inventory command and export that information into your SQL Server table. Once again, the downloadable version of this includes the *entire* script module, for your convenience.

Listing 26.4 Adding a command to export data to SQL Server

```
function Export-DiskInfoToSQL {
    [CmdletBinding()]
    param(
        [Parameter(Mandatory=$True,
                   ValueFromPipeline=$True)]
        [object[]]$DiskInfo
    )
    BEGIN {
        New-DiskInfoSQLTable
```

```
        $conn = New-Object System.Data.SqlClient.SqlConnection
        $conn.ConnectionString = $DiskInfoSqlConnection
        $conn.Open()
        $cmd = New-Object System.Data.SqlClient.SqlCommand
        $cmd.Connection = $conn
    }
    PROCESS {
        ForEach ($object in $DiskInfo) {
            if ($object.size -eq $null) {
                $size = 0
            } else {
                $size = $object.size
            }
            if ($object.freespace -eq $null) {
                $freespace = 0
            } else {
                $freespace = $object.freespace
            }
            $sql = @"
                INSERT INTO DiskInfo (ComputerName,
                    DiskSize,DriveType,FreeSpace,DriveID,DateAdde
                VALUES('$($object.ComputerName)',
                       $size,
                       $($object.DriveType),
                       $freespace,
                       '$($object.Drive)',
                       '$(Get-Date)')
"@
            $cmd.CommandText = $sql
            Write-Verbose "EXECUTING QUERY `n $sql"
            $cmd.ExecuteNonQuery() | Out-Null
        } #ForEach
    } #PROCESS
    END {
        $conn.Close()
    }
}
```

NOTE

Notice how we're checking to see whether `Size` and `FreeSpace` are `Null`? That can happen with disks like optical drives. We set those values to 0 in those cases so that we have a valid value to add to the database.

There's a big caveat that we need to point out. The new command's –

`DiskInfo` parameter does accept pipeline input—but you'll notice that it accepts *anything*, because its data type is `System.Object`. It's therefore entirely possible to pipe it a service object, a process object, or something else it won't know how to deal with. You can't do much about that. Yes, you could modify the `Get-DiskInfo` function to add a custom type name, but that won't allow you to specify that type name as the only allowable input to `Export-DiskInfoToSQL`; PowerShell unfortunately doesn't work that way. If you wanted to tightly couple these two commands and ensure that `Export-DiskInfoToSQL` could only accept the objects produced by `Get-DiskInfo`, you'd need to create your own class. PowerShell v5 and later can do that, but it's a more complex topic that's out of scope for this book. (*The PowerShell Scripting & Toolmaking Book* gets into it, and because it is online only, it can be updated. The situation with classes in PowerShell is highly fluid and ever-changing at this time.) For now, you must accept that you need to be careful about how you use `Export-DiskInfoToSQL`.

Listing 26.5 Adding member checks for input objects

```
function Export-DiskInfoToSQL {
    [CmdletBinding()]
    param(
        [Parameter(Mandatory=$True,
                   ValueFromPipeline=$True)]
        [object[]]$DiskInfo
    )
    BEGIN {
        New-DiskInfoSQLTable
        $conn = New-Object System.Data.SqlClient.SqlConnection
        $conn.ConnectionString = $DiskInfoSqlConnection
        $conn.Open()
        $cmd = New-Object System.Data.SqlClient.SqlCommand
        $cmd.Connection = $conn
        $checks = 0
    }
    PROCESS {
        if ($checks -eq 0) {            #A
            $checks++
            $props = $DiskInfo[0] |
                     Get-Member -MemberType Properties |
                     Select-Object -Expand name
            if ($props -contains 'Computername' -and
                $props -contains 'Drive' -and
                $props -contains 'DriveType' -and
```

```
                $props -contains 'FreeSpace' -and
                $props -contains 'Size') {
                    Write-Verbose "Input object passes check"
                } else {
                    Write-Error "Illegal input object"
                    Break
                }
        }
        ForEach ($object in $DiskInfo) {
            if ($object.size -eq $null) {
                $size = 0
            } else {
                $size = $object.size
            }
            if ($object.freespace -eq $null) {
                $freespace = 0
            } else {
                $freespace = $object.freespace
            }
            $sql = @"
                INSERT INTO DiskInfo (ComputerName,
                    DiskSize,DriveType,FreeSpace,DriveID,DateAdde
                VALUES('$($object.ComputerName)',
                       $size,
                       $($object.DriveType),
                       $freespace,
                       '$($object.Drive)',
                       '$(Get-Date)')
"@
            $cmd.CommandText = $sql
            Write-Verbose "EXECUTING QUERY `n $sql"
            $cmd.ExecuteNonQuery() | Out-Null
        } #ForEach
    } #PROCESS
    END {
        $conn.Close()
    }
}
```

Avoiding SQL injection

In listing 26.5, we left intact something that's a no-no for most public-facing applications: dynamically constructing a query by inserting variable contents into a string. In production-style applications, this opens you to an attack called *SQL injection*. We're fairly safe from it because we're the only ones

using this database, but it's something you need to be aware of and read up on if you start to accept data provided by other people.

What you *could* do, and what the listing does, is create some checks on the input to the command. We decided to ensure the objects we fed had the expected properties. This will slightly slow things down as we make the check, so we only check the first object fed to us and assume all the others are just like it.

Go ahead and put some data into the database:

```
get-diskinfo $env:computername | Export-DiskInfoToSQL
```

26.5 Querying data from SQL Server

Although we don't think there's an immediate real-world use for this—our intent would be to load data into SQL Server and leave it there for Reporting Services to create reports from—we want to show you an example of querying data. The following listing is the final chunk of code to add to your module. Again, we suggest using the downloadable version if you want to try this, because it has all the code in one place.

Listing 26.6 Adding a command to retrieve data from SQL Server

```
function Import-DiskInfoFromSQL {
    [CmdletBinding()]
    Param()
        $conn = New-Object System.Data.SqlClient.SqlConnection
        $conn.ConnectionString = $DiskInfoSqlConnection
        $conn.Open()
        $cmd = New-Object System.Data.SqlClient.SqlCommand
        $cmd.Connection = $conn
        $sql = @"
            SELECT ComputerName,DiskSize,DriveType,FreeSpace,
            DriveID,DateAdded
            FROM DiskInfo
            ORDER BY DateAdded ASC
"@
        $cmd.CommandText = $sql
        $reader = $cmd.ExecuteReader()
        # spin through the results
```

```
        while ($reader.read()) {                          #A
            $props = @{'ComputerName' = $reader['ComputerName']
                       'Size' = $reader['DiskSize']
                       'DriveType' = $reader['DriveType']
                       'FreeSpace' = $reader['FreeSpace']
                       'Drive' = $reader['DriveId']
                       'DateAdded' = $reader['DateAdded']}
            New-Object -TypeName PSObject -Property $props
        }
        $conn.Close()
}
```

Notice again that you follow the toolmaking patterns we've taught throughout this book—you produce a command, it uses parameters for its input (and, in this case, a module-level variable), produces objects as output, and so on. The only thing we've omitted in this book, purely for space considerations, is the comment-based help we'd typically always include.

We also want to acknowledge that not everyone would code this command as we did. Some folks prefer to use a `DataTable` object versus a `DataReader`, and we admit that a DataTable can be faster for this precise scenario. We took this approach because it's more educational and procedural. It reads the result set one line at a time and constructs output objects one at a time, reinforcing the pattern presented throughout this book.

Finally, you'll notice a discrepancy if you've been paying close attention. The original `Get-DiskInfo` outputs an object having `Size` and `Drive` properties, and `Import-DiskInfoFromSQL` mirrors those output property names. But the table in SQL Server uses DiskSize and DriveID as column names. Why the mismatch? So that we could emphasize that the *table structure doesn't need to exactly match the object structure*. In this case, the `Import` and `Export` functions take care of translating the property names into what the table uses. This is a useful technique when you don't have control over either the object structure or the table structure and need to switch things up as you store and retrieve data.

To complete the circle, let's pull the information we just added:

```
PS C:\> Import-DiskInfoFromSQL
DateAdded    : 9/23/2023 5:24:01 PM
Drive        : C:
```

```
FreeSpace    : 27722903552
ComputerName : WIN11
DriveType    : 3
Size         : 206266429440
DateAdded    : 9/23/2023 5:24:01 PM
Drive        : D:
FreeSpace    : 16025034752
ComputerName : WIN11
DriveType    : 3
Size: 26843541504
```

26.6 Summary

We hope this chapter has demonstrated how relatively straightforward it is to use SQL Server as a database rather than something database-esque like Excel. You've followed proper toolmaking practices and created a set of commands that work with disk-inventory information. You've enabled automated reporting through SQL Server Reporting Services if you decide to sit down and design the reports there. By using a scheduled task to run the inventory and Reporting Services to create periodic reports automatically, you could completely automate data collection and data reporting processes, taking yourself out of the loop and freeing up your time to work on other tasks.

27 Never the end

Welcome to the end! Or is it? Of course not—you're really just beginning, but you've made it to the point where you can start to be an effective toolmaker. Now it's time to begin thinking about what comes next.

27.1 Welcome to toolmaking

At this point, we're hoping you've seen the light about this *toolmaking* word. It isn't just about scripting, is it? It's about making small units of work that follow Power-Shell's rules, so that they can connect to each other. It's about making *controllers* that put those tools into a specific situation and context, giving those tools a purpose for that moment in time—but leaving the tools themselves free to have another purpose at another time. Hopefully, you've also seen the value in examining how PowerShell does things natively and in duplicating its approaches in your own work.

The best compliment we get when we teach this material—whether in a class, at a conference, or in a book like this—is something along the lines of, "Well, thanks a lot—now *I have to go and rewrite all of my scripts!*" We love that, because it shows that we've not only taught someone effectively, but also done a good job of making them realize how valuable this approach is. Of course, this doesn't literally mean they need to rewrite all of their existing work. If you have something that works, let it be. But if the occasion arises where you need to fix a bug or add a feature, then by all means begin to incorporate the changes inspired by this book.

Of course, we can only take you so far in one book. You're going to need to go further, and you'll need to do that soon. Like, as soon as you finish reading this chapter—because until you start doing this stuff for real, your brain won't completely lock on to the concepts and the techniques. You're already forgetting stuff from chapter 2—so it's crucial to start putting things to work, right now.

27.2 Taking your next step

Our best advice is to *stop learning* for a minute and *start doing*. You have plenty of facts and techniques to begin tackling your first tool and your first controller. As soon as you do, you'll realize that you forgot a few things—and that's great news! No, really—you'll realize that you forgot something, flip to the right chapter, and refresh yourself. This act of relearning strengthens the bonds between the neurons in your brain that are responsible for remembering this material, which will make it easier to recall the information the next time. But you won't realize you've forgotten, and you won't take the steps to relearn, until you dive in and *start doing*.

With that in mind, we have a few recommendations for your next step:

- *Don't try to tackle the biggest problem on your plate*. Look for something small that you may already have a pretty good idea of how to conquer. That way, you can focus on the new approaches and techniques you've learned. As you gain confidence, you can start building ever-more-complex tools and controllers.
- *Don't give in to expediency*. The approaches and techniques we've shared don't add a lot of time to your coding, but they do add a bit. You're going to have to take time to do parameter design, for example, and code for accepting pipeline input. The investment is worth it, because you'll quickly begin to do those things almost by reflex. The alternative—"I'll bang it out for now and go back and fix it later"—is a bad idea. You may not have time later to do it right, and then you'll be stuck with something that is, well, wrong.
- *Get stuck*. For better or for worse, human brains seem to learn better when they're conquering a problem than when they're being passively fed information. With that in mind, dive into something, get stuck, and unstick yourself. Forums like the ones at ServerFault.com and PowerShell.org are valuable resources—state your problem, describe what you've tried, and provide some details (like error messages) about what didn't work. *Don't ask people to write your script for you*—be clear that you only need a nudge in the right direction.
- *Share*. Every time you figure out a problem, blog about it. The act of recalling the problem and the solution is what strengthens neural

connections in your brain. Writing down what you did—even if it's for an internal company blog that nobody but you and your team will read—helps you learn. And if you're able to blog publicly, you'll help someone. Remember, a lot of people are smarter than you, but due to this thing called a birth rate, there are always new people who are struggling with the same thing you just solved. Help them out.

- *Do the math*. Anytime you're automating something, begin by figuring out how much time your organization spends doing it manually per year. Calculate that in hours, if you can, perhaps by looking at your help desk ticketing solution for a report. Get an average salary for the people who spend time solving that problem manually. Multiply that salary by 1.14 (a rough way of calculating a fully loaded salary, at least in most of North America), and then divide by 2,000 (the average number of working hours in a year). The result is a fully loaded hourly rate for that person, which you can multiply by the number of hours being spent performing a task manually. The end result is the amount of money your organization spends on that problem. It becomes easy to calculate a return on investment when you know how much was being spent, how long it took you to automate the problem, and how much time needs to be spent now that the problem is automated.
- *Don't "script by Google."* That is, when starting a new project, your first step should not be to open a browser and search for an existing script. Even if you find something, how do you know it works? Will it work in your environment? Do you have the PowerShell chops to determine whether it's good PowerShell? Plus, you'll most likely spend a lot of time revising hard-coded variables and the like. That's a waste of time. You'd be better off beginning with PowerShell's help system and going through the process yourself. Yeah, it might seem to take longer, but you'll learn; and at the end, you'll have a tool that you know works in your environment. It's fine to search for examples of how to use a particular cmdlet or parameter, but you'll never succeed with copy-and-paste scripting.

This is all about becoming a more professional toolmaker.

27.3 What's in your future?

So, what’s in the long term? What are some of the things you should be exploring in the PowerShell universe? Keep in mind that it’s a rapidly changing space and requires constant attention if you want to keep up. Here are some areas to think about:

- PowerShell Core is an open source project at GitHub.com/powershell that will run on macOS, a variety of Linux distros, and of course Windows. Explore it.
- Open source projects like PlatyPS, Pester, and the PowerShell Script Analyzer are great tools—look into them, and start learning to use them in your everyday toolmaking. Even better, get involved by posting issues and maybe even contributing code.
- Community events like PowerShell Saturdays, the annual PowerShell + DevOps Global Summit (powershellsummit.org), and regional PowerShell Conferences (PowerShell Conference Europe and PowerShell Conference Asia, for example) are all worth your time—as are the dozens of local PowerShell user groups scattered throughout the world.
- Microsoft Virtual Academy (MVA) is a great free source of videos for a variety of PowerShell topics, including Desired State Configuration (DSC—a topic Don has written a book on: The DSC Book, https://leanpub.com/the-dsc-book). Use these MVA videos to get a quick jump-start into a topic, and then jump off and explore independently.
- Finally, always be on the lookout for new sources of learning material. Manning has a number of books and new things coming out all the time that may help. We’re also responsible for a lot of content on Pluralsight.com. If nothing else, follow us on Twitter (@concentrateddon and @jeffhicks) to see what we’re up to and pointing people toward.

PowerShell and toolmaking are a big, exciting universe with a lot to explore. Set aside a little time each week to catch up with the latest and explore something new. And, of course, keep toolmaking in your own organization!

welcome

Welcome to *Learn PowerShell Scripting in a Month of Lunches, Second Edition*. I'm glad you have decided to join us as I update and revise this classic book.

This book is for people who already work with PowerShell, and now want to start using it to its maximum functionality. To automate complex tasks and processes, you need to learn scripting, and that is what this book will teach you. The goal is to provide you with all the fundamental information you need to start scripting and creating basic PowerShell tools. If you are already scripting, we think this book can teach you better and more ways to do it.

Most of the preliminary information you need is covered in chapter 1, but here are a few things we should mention up front. First and foremost, we strongly suggest that you follow along with the examples in the book. In order to follow along, you'll need PowerShell installed. This book was written based on PowerShell 7.2, but honestly, 99% of the book also applies to earlier versions of Windows PowerShell.

You'll also need to install a script editor. Though Windows PowerShell's Integrated Script Editor (ISE) is included on client versions of Windows, we recommend removing it, since the PowerShell team has not put any maintenance or support into it since Windows 7 was released. Microsoft recommends Visual Studio Code (VS Code), which is free and cross-platform. Download that, and in chapter 2 we'll show you how to set it up.

Finally, you need to be able to run the PowerShell console, and your editor, "as Administrator" on your computer, mainly so that the administrative examples we're sharing with you will work.

Regarding Linux, mac and other operating systems, Visual Studio Code and PowerShell are both cross-platform. Every single concept and practice in this book applies to PowerShell running on systems other than Windows. But the examples we use will, as of this writing, only run-on Windows.

Thanks for joining us!

If you have any questions, comments, or suggestions, please share them in Manning's liveBook Discussion forum.

—James Petty

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