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Using Objects

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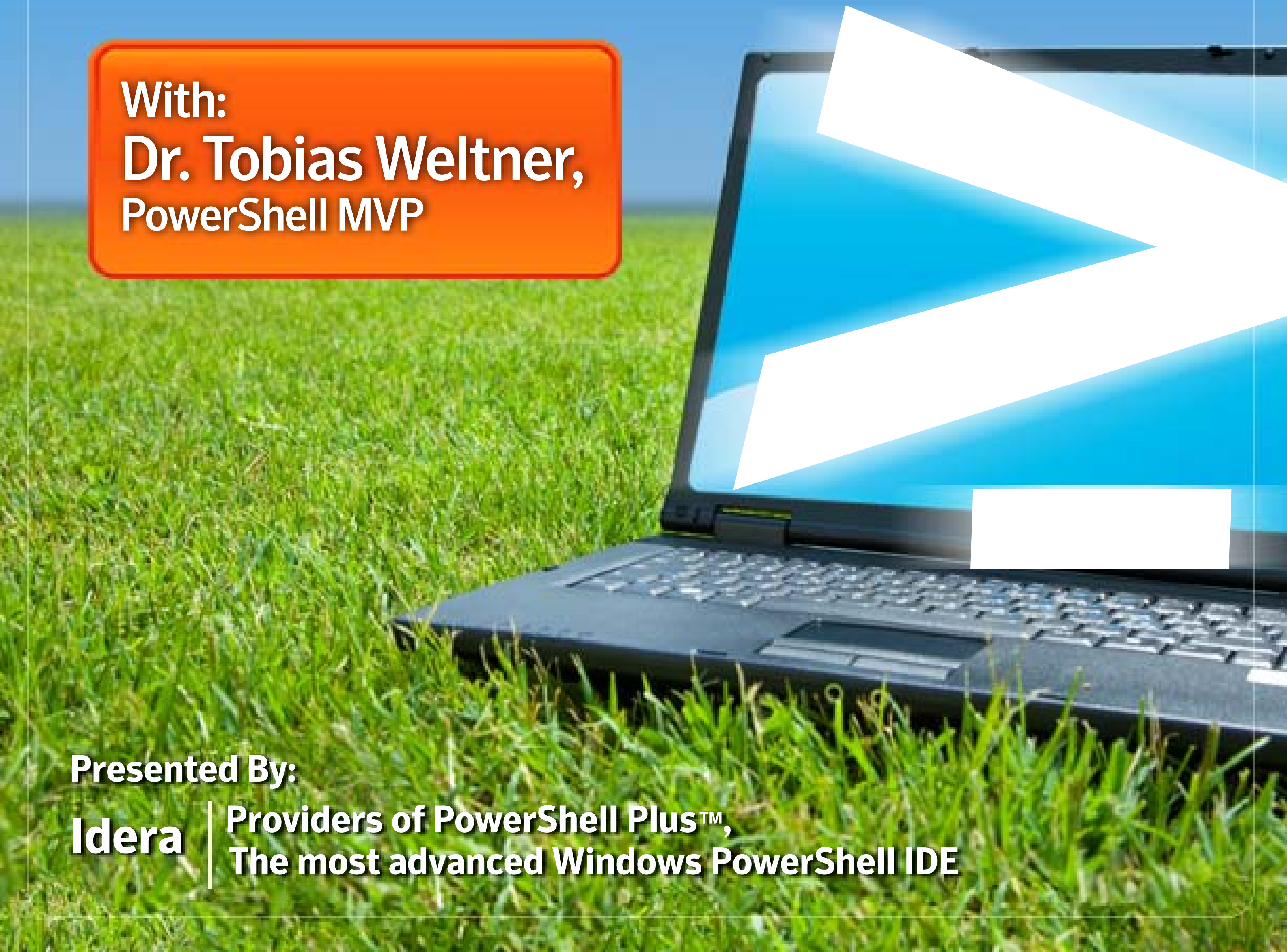
With:
Dr. Tobias Weltner,
PowerShell MVP



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About the Author

Dr. Tobias Weltner is one of the most visible PowerShell MVPs in Europe. He has published more than 80 books on Windows and Scripting Techniques with Microsoft Press and other publishers, is a regular speaker at conferences and road shows and does high level PowerShell and Scripting trainings for companies throughout Europe. He created the powershell.com website and community in an effort to help people adopt and use PowerShell more efficiently. As software architect, he created a number of award-winning scripting tools such as SystemScripter (VBScript), the original PowerShell IDE and PowerShell Plus, a comprehensive integrated PowerShell development system.

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Sincerely,

Dr. Tobias Weltner

Windows PowerShell MVP

Mastering PowerShell

Chapters

Extras

CHAPTER 1.

The PowerShell Console

Welcome to PowerShell! This chapter will introduce you to the PowerShell console and show you how to configure it, including font colors and sizes, editing and display options.

Topics Covered:

Starting PowerShell

After you installed PowerShell, you'll find the PowerShell icon on the Start Menu in the program folder *Windows PowerShell*. Open this program folder and click on *Windows PowerShell* and the PowerShell console comes up. By the way, if you aren't able to find the program folder, PowerShell is probably not installed on your computer. It is an optional download from Microsoft for Windows XP, Server 2003, and Windows Vista.

You can also start PowerShell directly. Just press (Windows)+(R) to open the *Run* window and then enter *powershell* (Enter). If you use PowerShell often, you should open the program folder for *Windows PowerShell* and right-click on *Windows PowerShell*. That will give you several options:

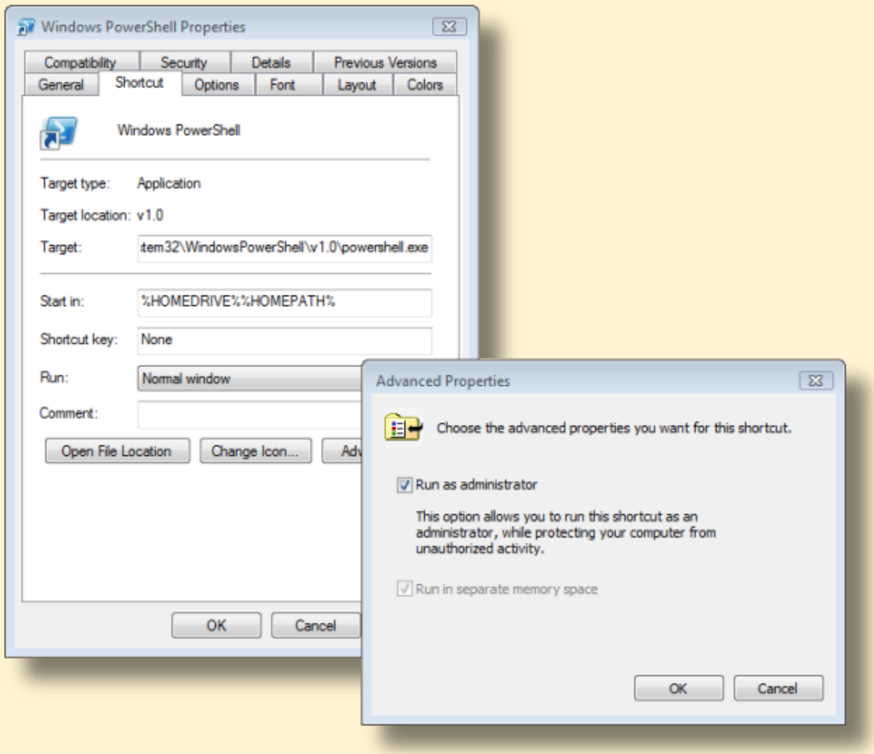
- **Add to the start menu:** On the context menu, click on *Pin to Start Menu* so that PowerShell will be displayed directly on your start menu from now on and you won't need to open its program folder first.
- **Quick Launch toolbar:** Click *Add to Quick Launch toolbar* if you use Windows Vista and would like to see PowerShell right on the Quick Launch toolbar inside your taskbar. Windows XP lacks this command so XP users will have to add PowerShell to the Quick Launch toolbar manually.
- **Keyboard shortcuts:** Administrators particularly prefer using a keyboard instead of a mouse. If you select *Properties* on the context menu, you can specify a key combination in the *hot-key* field. Just click on this field and press the key combination intended to start PowerShell, such as (Alt)+(P). In the properties window, you also have the option of setting the default window size to start PowerShell in a normal, minimized, or maximized window.
- **Autostart:** If you use PowerShell daily, it makes sense to Autostart the application. Then, it will automatically launch the PowerShell window when Windows starts up so all you have to do to bring it up is to click on its window button on the taskbar. If you want to set up a PowerShell autostart, open the *Windows PowerShell 1.0* program folder and right-click on *Windows PowerShell* on the *All Programs* menu of your start menu. On the context menu, select *Copy*. Next, open *Startup* folder, right-click on a blank area, and select paste on the context menu. This will place a PowerShell shortcut in the folder. All you have to do now is click on the shortcut with the right button of your mouse and choose *Properties*. Specify the window size as *Minimized*.

important

Here is a special note for Vista users: The default settings of Windows Vista start all programs without administrator privileges. This applies to the PowerShell console as well. So, even if you have administrator privileges, you will initially have no access to your administrator rights when using the PowerShell console. That's a new security feature that does make sense. You'd be surprised to see how many routine tasks can be performed without these powerful (and potentially dangerous) rights.

If you need more privileges because commands aren't working right or your system complains about lacking administrator rights, then request your full administrator privileges. To do so, right-click on the PowerShell entry on your start menu and select *Run As Administrator* on the context menu. The PowerShell console window won't show by default whether you have enabled full administrator privileges, but you can add that feature later (see Chapter 9).

If you'd like to always launch PowerShell with full administrator privileges, click on the shortcut on the start menu with the right button of your mouse and choose *Properties*. Then click below right on *Advanced* and activate the option *Run As Administrator*.



Target type: Application
Target location: v1.0
Target: tem32\WindowsPowerShell\v1.0\powershell.exe
Start in: %HOMEDRIVE%%HOMEPATH%
Shortcut key: None
Run: Normal window
Comment:

Choose the advanced properties you want for this shortcut.

☑ Run as administrator

This option allows you to run this shortcut as an administrator, while protecting your computer from unauthorized activity.

☑ Run in separate memory space

Figure 1.1: How to always open PowerShell with administrator rights

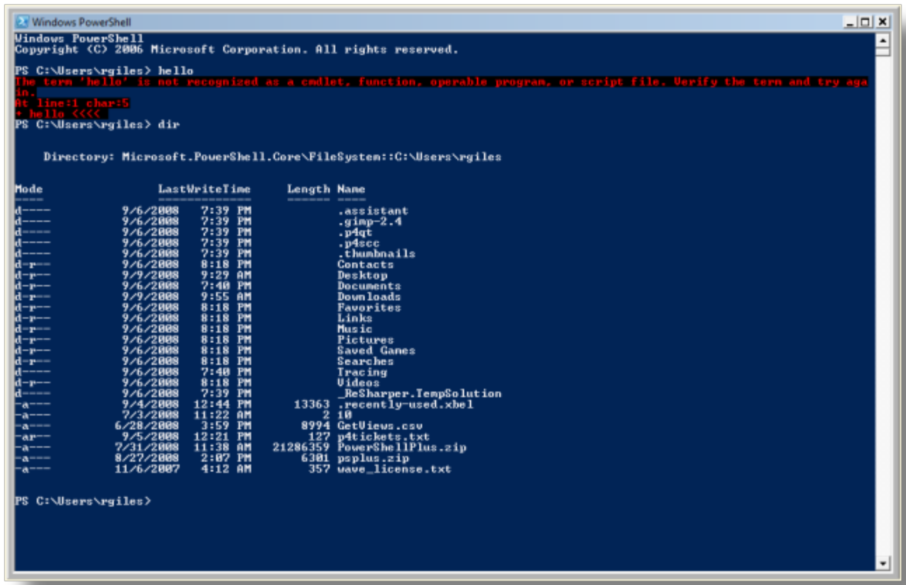
(Run without administrative privileges whenever possible)

First Steps with the Console

After PowerShell starts, its console window opens, and you see a blinking text prompt, asking for your input with no icons or menus. PowerShell is a command console and almost entirely operated via keyboard input. The prompt begins with "PS" and after it is the path name of the directory where you are located. Start by trying out a few commands. For example, type:

```
hello (Enter)
```

As soon as you press (Enter), your entry will be sent to PowerShell. Because PowerShell has never heard of the command "hello" you will be confronted with an error message highlighted in red.



```
Windows PowerShell
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PS C:\Users\rgiles> hello
The term 'hello' is not recognized as a cmdlet, function, operable program, or script file. Verify the term and try aga
in.
At line:1 char:5
+ hello <<<<
PS C:\Users\rgiles> dir


    Directory: Microsoft.PowerShell.Core\FileSystem::C:\Users\rgiles


Mode                LastWriteTime     Length Name
----                -------------     ------ ----
d----          9/6/2008   7:39 PM            .assistant
d----          9/6/2008   7:39 PM            .gimp-2.4
d----          9/6/2008   7:39 PM            .p4qt
d----          9/6/2008   7:39 PM            .p4scc
d----          9/6/2008   7:39 PM            .thumbnails
d-r--          9/6/2008   8:18 PM            Contacts
d-r--          9/9/2008   9:29 AM            Desktop
d-r--          9/6/2008   7:40 PM            Documents
d-r--          9/9/2008   9:55 AM            Downloads
d-r--          9/6/2008   8:18 PM            Favorites
d-r--          9/6/2008   8:18 PM            Links
d-r--          9/6/2008   8:18 PM            Music
d-r--          9/6/2008   8:18 PM            Pictures
d-r--          9/6/2008   8:18 PM            Saved Games
d-r--          9/6/2008   8:18 PM            Searches
d----          9/6/2008   7:40 PM            Tracing
d-r--          9/6/2008   8:18 PM            Videos
d----          9/6/2008   7:39 PM            _ReSharper.TempSolution
-a---          9/4/2008  12:44 PM      13363 .recently-used.xbel
-a---          7/3/2008  11:22 AM          2 10
-a---         6/28/2008   3:59 PM       8994 GetViews.csv
-ar--          9/5/2008  12:21 PM        127 p4tickets.txt
-a---         7/31/2008  11:38 AM   21286359 PowerShellPlus.zip
-a---         8/27/2008   2:07 PM       6301 psplus.zip
-a---         11/6/2007   4:12 AM        357 wave_license.txt


PS C:\Users\rgiles>
```

Figure 1.2: First commands in the PowerShell console

For example, if you'd like to see which files and folders are in your current directory, then type *dir* (Enter). You'll get a text listing of all the files in the directory. PowerShell's communication with you is always text-based. PowerShell can do much more than display simple directory lists. Just pick a different command as the next one provides a list of all running processes:

Get-Process (Enter)

PowerShell's advantage is its tremendous flexibility since it allows you to control and display nearly all the information and operations on your computer. The command *cls* deletes the contents of the console window and the *exit* command ends PowerShell.

Incomplete and Multi-line Entries

Whenever you enter something PowerShell cannot understand, you get a red error message, explaining what went wrong. However, if you enter something that isn't wrong but incomplete (like a string with one missing closing quote), PowerShell gives you a chance to complete your input. You then see a double-prompt (">>"), and once you completed the line and pressed ENTER twice, PowerShell executes the command. You can also bail out at any time and cancel the current command or input by pressing: (Ctrl)+(C).

The "incomplete input" prompt will also appear when you enter an incomplete arithmetic problem like this one:

```
2 + (Enter)
>> 6 (Enter)
>> (Enter)

  8
```

This feature enables you to make multi-line PowerShell entries:

```
"This is my little multiline entry.(Enter)
>> I'm now writing a text of several lines. (Enter)
>> And I'll keep on writing until it's no longer fun."(Enter)
>>(Enter)

  This is my little multiline entry.
  I'm now writing a text of several lines.
  And I'll keep on writing until it's no longer fun.
```

The continuation prompt generally takes its cue from initial and terminal characters like open and closed brackets or quotation marks at both ends of a string. As long as the symmetry of these characters is incorrect, you'll continue to see the prompt. However, you can activate it even in other cases:

```
dir `(Enter)
>> -recurse(Enter)
>>(Enter)
```

So, if the last character of a line is what is called a "backtick" character, the line will be continued. You can retrieve that special character by pressing (`).

Important Keyboard Shortcuts

Shortcuts are important since almost everything in PowerShell is keyboard-based. For example, by pressing the keys (Arrow left) and (Arrow right), you can move the blinking cursor to the left or right. Use it to go back and correct a typo. If you want to move the cursor word by word, hold down (Ctrl) while pressing the arrow keys. To place the cursor at the beginning of a line, hit (Home). Pressing (End) will send the cursor to the end of a line.

note

If you haven't entered anything, then the cursor won't move since it will only move within entered text. There's one exception: if you've already entered a line and pressed (Enter) to execute the line, you can make this line appear again character-by-character by pressing (Arrow right).

Deleting Incorrect Entries

If you've mistyped something, press (Backspace) to delete the character to the left of the blinking cursor. (Del) erases the character to the right of the cursor. And you can use (Esc) to delete your entire current line.

The hotkey (Ctrl)+(Home) works more selectively: it deletes all the characters at the current position up to the beginning of the line. Characters to the right of the current position (if there are any) remain intact. (Ctrl)+(End) does it the other way around and deletes everything from the current position up to the end of the line. Both combinations are useful only after you've pressed (Arrow left) to move the cursor to the middle of a line, specifically when text is both to the left and to the right of the cursor.

Overtype Mode

If you enter new characters and they overwrite existing characters, then you know you are in type-over mode. By pressing (Insert) you can switch between insert and type-over modes. The default input mode depends on the console settings you select. You'll learn more about console settings soon.

Command History: Reusing Entered Commands

For example, you don't have to re-type commands to edit them. Simply press (Arrow up) to re-display the command that you entered. Press (Arrow up) and (Arrow down) to scroll up and down your command history. Using (F5) and (F8) do the same as the up and down arrow keys.

This command history feature is extremely useful. Later, you'll learn how to configure the number of commands the console "remembers." The default setting is the last 50 commands. You can display all the commands in your history by pressing (F7) and then scrolling up and down the list to select commands using (Arrow up) and (Arrow down) and (Enter).

tip

The numbers before the commands in the Command History list only denote the sequence number. You cannot enter a number to select the associated command. What you can do is move up and down the list by hitting the arrow keys.

Simply press (F9) to 'activate' the numbers so that you can select a command by its number. This opens a menu that accepts the numbers and returns the desired command.

The keyboard sequence (Alt)+(F7) will clear the command history and start you off with a new list.

(F8) provides more functionality than (Arrow up) as it doesn't just show the last command you entered, but keeps a record of the characters you've already typed in. If, for example, you'd like to see all the commands you've entered that begin with "d", type:

```
d(F8)
```

Press (F8) several times. Every time you press a key another command will be displayed from the command history provided that you've already typed in commands with an initial "d."

Automatically Completing Input

An especially important key is (Tab). It will save you a great deal of typing (and typing errors). When you press this key, PowerShell will attempt to complete your input automatically. For example, type:

```
cd (Tab)
```

The command *cd* changes the directory in which you are currently working. Put at least one space behind the command and then press (Tab). PowerShell suggests a subdirectory. Press (Tab) again to see other suggestions. If (Tab) doesn't come up with any suggestions, then there probably aren't any subdirectories available.

This feature is called AutoComplete, which works in many places. For example, you just learned how to use the command *Get-Process*, which lists all running processes. If you want to know what other commands there are that begin with "Get-", then type:

```
Get-(Tab)
```

Just make sure that there's no space before the cursor when you press (Tab). Keep hitting (Tab) to see all the commands that begin with "Get-".

tip

A more complete review of the AutoComplete feature is available in Chapter 9.

AutoComplete works really well with long path names that require a lot of typing. For example:

```
c:\p(Tab)
```

Every time you press (Tab), PowerShell will prompt you with a new directory or a new file that begins with "c:\p." So, the more characters you type, the fewer options there will be. In practice, you should type in at least four or five characters to reduce the number of suggestions.

When the list of suggestions is long, it can take a second or two until PowerShell has compiled all the possible suggestions and displays the first one.

tip

Wildcards are allowed in path names. For example, if you enter *c:\pr*e* (Tab) in a typical Windows system, PowerShell will respond with "c:\Program Files".

PowerShell will automatically put the entire response inside double quotation marks if the response contains whitespace characters.

Scrolling Console Contents

The visible part of your console depends on the size of your console window, which you can change with your mouse. Drag the window border while holding down your left mouse button until the window is the size you want. Note that the actual contents of the console, the "screen buffer," don't change. So, if the window is too small to show everything, you should use the scroll bars.

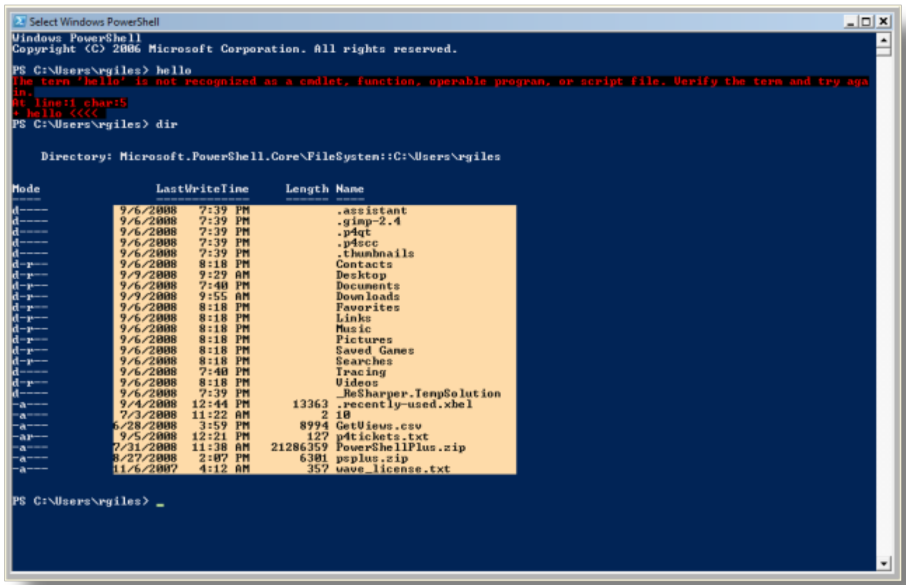
Selecting and Inserting Text

Use your mouse if you'd like to select text inside the PowerShell window and copy it onto the clipboard. Move the mouse pointer to the beginning of the selected text, hold down the left mouse button and drag it over the text area that you want to select.

QuickEdit Mode

QuickEdit is the default mode for selecting and copying text in PowerShell. Select the text using your mouse and PowerShell will highlight it. After you've selected the text, press (Enter) or right-click on the marked area. This will copy the selected text to the clipboard. which you can now paste into other applications. To unselect press (Esc).

You can also insert the text in your console at the blinking command line by right-clicking your mouse.



```
Windows PowerShell
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PS C:\Users\rgiles> hello
The term 'hello' is not recognized as a cmdlet, function, operable program, or script file. Verify the term and try aga
in.
At line:1 char:5
+ hello <<<<
PS C:\Users\rgiles> dir


    Directory: Microsoft.PowerShell.Core\FileSystem::C:\Users\rgiles


Mode                LastWriteTime     Length Name
----                -------------     ------ ----
d----          9/6/2008   7:39 PM            .assistant
d----          9/6/2008   7:39 PM            .gimp-2.4
d----          9/6/2008   7:39 PM            .p4qt
d----          9/6/2008   7:39 PM            .p4scc
d----          9/6/2008   7:39 PM            .thumbnails
d-r--          9/6/2008   8:18 PM            Contacts
d-r--          9/9/2008   9:29 AM            Desktop
d-r--          9/6/2008   7:40 PM            Documents
d-r--          9/9/2008   9:55 AM            Downloads
d-r--          9/6/2008   8:18 PM            Favorites
d-r--          9/6/2008   8:18 PM            Links
d-r--          9/6/2008   8:18 PM            Music
d-r--          9/6/2008   8:18 PM            Pictures
d-r--          9/6/2008   8:18 PM            Saved Games
d-r--          9/6/2008   8:18 PM            Searches
d----          9/6/2008   7:40 PM            Tracing
d-r--          9/6/2008   8:18 PM            Videos
d----          9/6/2008   7:39 PM            _ReSharper.TempSolution
-a---          9/4/2008  12:44 PM      13363 .recently-used.xbel
-a---          7/3/2008  11:22 AM          2 10
-a---         6/28/2008   3:59 PM       8994 GetViews.csv
-ar--          9/5/2008  12:21 PM        127 p4tickets.txt
-a---         7/31/2008  11:38 AM   21286359 PowerShellPlus.zip
-a---         8/27/2008   2:07 PM       6301 psplus.zip
-a---         11/6/2007   4:12 AM        357 wave_license.txt


PS C:\Users\rgiles> _
```

Figure 1.3: Marking and copying text areas in QuickEdit mode

Standard Mode

If QuickEdit is turned off and you are in Standard mode, the simplest way to mark and copy text is to right-click in the console window. If QuickEdit is turned off, a context menu will open.

Select *Mark* to mark text and *Paste* if you want to insert the marked text (or other text contents that you've copied to the clipboard) in the console.

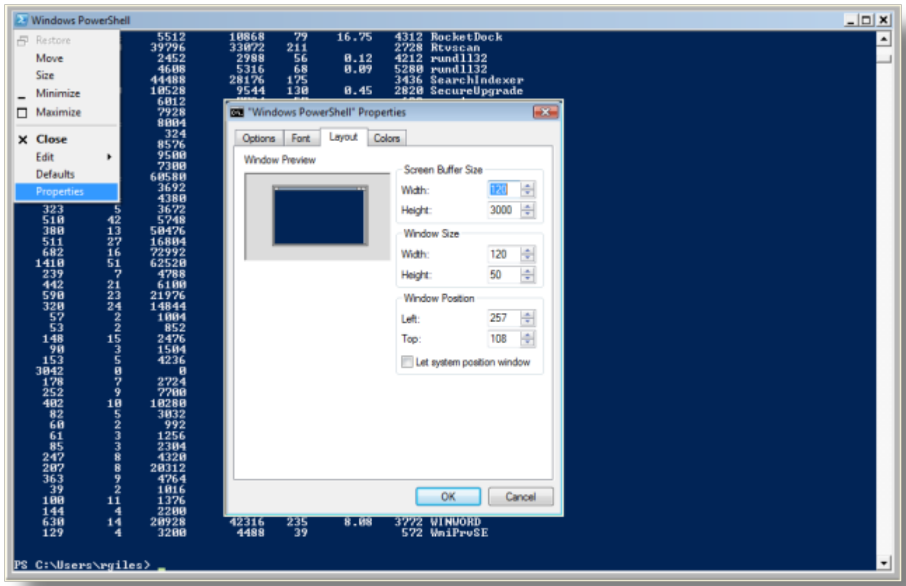
It's usually more practical to activate QuickEdit mode so that you won't have to use to the context menu.

Customizing the Console

You can customize a variety of settings in the console including edit mode, screen buffer size, font colors, font sizes etc.

Opening Console Properties

The basic settings of your PowerShell console are configured in a special *Properties* dialog box. Click on the PowerShell icon on the far left of the title bar of the console window to open it.



```
                     5512     10868    79    16.75    4312 RocketDock
                    39796     33072   211             2728 Rtvscan
                     2452      2988    56     0.12    4212 rundll32
                     4608      5316    68     0.09    5280 rundll32
                    44488     28176   175             3436 SearchIndexer
                    10528      9544   130     0.45    2820 SecureUpgrade
                     6012
                     7928
                     8004
                      324
                     8576
                     9500
                     7300
                    60580
                     3692
                     4380
     323      5      3672
     510     42      5748
     380     13     50476
     511     27     16804
     682     16     72992
    1410     51     62520
     239      7      4788
     442     21      6100
     590     23     21976
     320     24     14844
      57      2      1004
      53      2       852
     148     15      2476
      90      3      1504
     153      5      4236
    3042      0         0
     178      7      2724
     252      9      7700
     402     10     10280
      82      5      3032
      60      2       992
      61      3      1256
      85      3      2304
     247      8      4320
     207      8     20312
     363      9      4764
      39      2      1016
     100     11      1376
     144      4      2200
     630     14     20928     42316   235     0.08    3772 WINWORD
     129      4      3200      4488    39              572 WmiPrvSE

PS C:\Users\rgiles> _
```

Screen Buffer Size
Width: 120
Height: 3000

Window Size
Width: 120
Height: 50

Window Position
Left: 257
Top: 108

☐ Let system position window

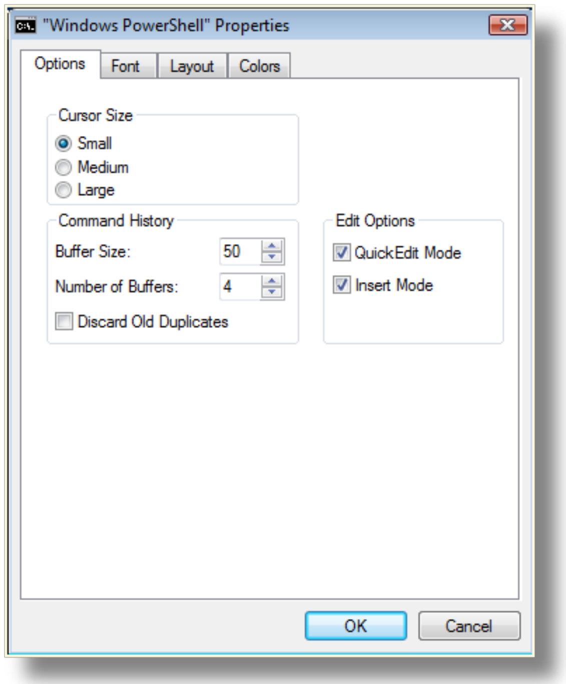
Figure 1.4: Opening console properties

That will open a context menu. You should select Properties and A dialog box will open.

To get help, click on the question mark button on the title bar of the window. A question mark is then pinned to your mouse pointer. Next, click on the option you need help for. The help appears as a ScreenTip window.

Defining Options

Under the heading *Options* are four panels of options:



Cursor Size
[✓ Small] Medium Large

Command History
Buffer Size: 50
Number of Buffers: 4
Discard Old Duplicates

Edit Options
[✓] QuickEdit Mode
[✓] Insert Mode

Figure 1.5: Defining the QuickEdit and Insert modes

- **Edit options**: You should select the QuickEdit mode as well as the insert mode. We've already discussed the advantages of the *QuickEdit mode*: it makes it much easier to select, copy, and insert text. The *insert mode* makes sure that new characters don't overwrite existing input so new characters will be added without erasing text you've already typed in when you're editing command lines.
- **Cursor size**: **H**ere is where you specify the size of the blinking cursor.
- **Display options**: Determine whether the console should be displayed as a window or full screen. The "window" option is best so that you can switch to other windows when you're working. The full screen display option is not available on all operating systems.
- **Command history**: Here you can choose how many command inputs the console "remembers". This allows you to select a command from the list by pressing (Arrow up) or (F7). The option *Discard Old Duplicates* ensures that the list doesn't have any duplicate entries. So, if you enter one command twice, it will appear only once in the history list.

Specifying Fonts and Font Sizes

On the *Font* tab, you can choose both the font and the font size displayed in the console.

The console often uses the raster font as its default. This font is available in a specific range of sizes with available sizes shown in the "Size" list. Scalable TrueType fonts are much more flexible. They're marked in the list by a "TT" symbol. When you select a TrueType font, you can choose any size in the size list or enter them as text in the text box. TrueType fonts can be dynamically scaled.

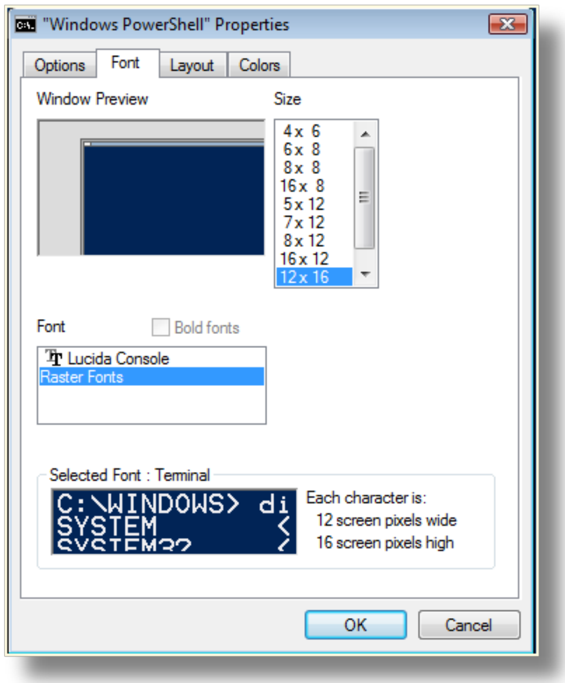


Figure 1.6: Specifying new fonts and font sizes

You should also try experimenting with TrueType fonts by using the "bold fonts" option. TrueType fonts are often more readable if they're displayed in bold.

pro tip

Your choice of fonts may at first seem a bit limited. To get more font choices, you can add them to the console font list. The limited default font list is supposed to prevent you from choosing unsuitable fonts for your console.

One reason for this is that the console always uses the same width for each character (fixed width fonts). This restricts the use of most Windows fonts because they're proportional typefaces: every character has its own width. For example, an "" is narrower than an "m". If you're sure that a certain font will work in the console, then here's how to add the font to the console font list.

Open your registry editor. In the key *HKEY_LOCAL_MACHINE\SOFTWARE\Microsoft\Windows NT\CurrentVersion\Console\TrueTypeFont* insert a new "string value" and give this entry the name "00" (numbers, not letters).

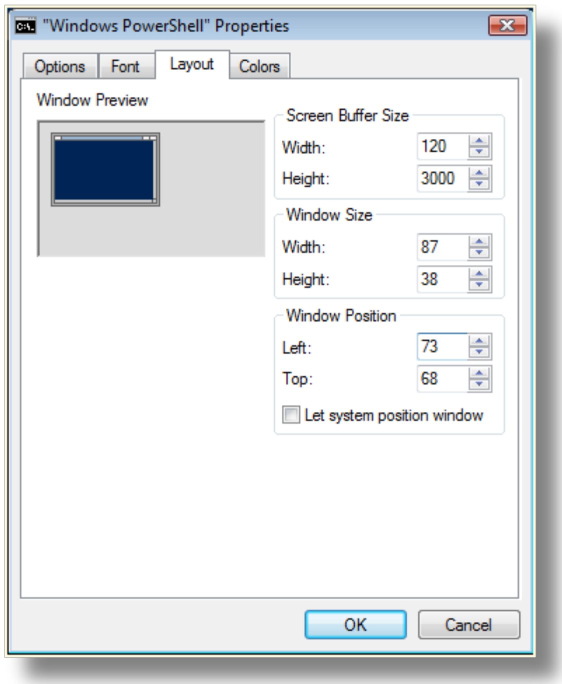
If there's already an entry that has this name, then call the new entry "000" or add as many zeroes as required to avoid conflicts with existing entries. You should then double-click your new entry to open it and enter the name of the font. The name must be exactly the same as the official font name, just the way it's stated under the key *HKEY_LOCAL_MACHINE\SOFTWARE\Microsoft\Windows NT\CurrentVersion\Fonts*.

The newly added font will now turn up in the console's option field. However, the new font will work only after you either log off at least once or restart your computer. If you fail to do so, the console will ignore your new font when you select it in the dialog box.

Setting Window and Buffer Size

On the *Layout* tab, you can specify how large the screen buffer should be, meaning how much information the console should "remember" and how far back you can scroll with the scroll bars.

You should select a width of at least 120 characters in the window buffer size area with the height should be at least 1,000 lines or larger. This gives you the opportunity to use the scroll bars to scroll the window contents back up so that you can look at all the results of your previous commands.



Width: 120
Height: 3000
Width: 87
Height: 38
Left: 73
Top: 68
Let system position window

Figure 1.7: Specifying the size of the window buffer

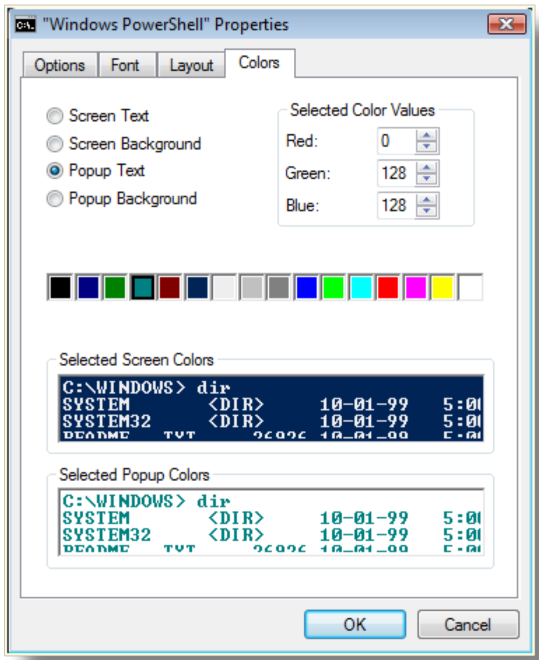
You can also set the window size and position on this tab if you'd like your console to open at a certain size and screen position on your display. Choose the option *Let system position window* and Windows will automatically determine at what location the console window will open.

Selecting Colors

On the *Colors* tab, you can select your own colors for four areas:

- **Screen text:** Console font
- **Screen background:** Console background color
- **Popup text:** Popup window font, such as command history's (F7)
- **Popup background:** Popup window background color

You have a palette of 16 colors for these four areas. So, if you want to specify a new font color, you should first select the option *Screen Text* and click on one of the 16 colors. If you don't like any of the 16 colors, then you can mix your own special shade of color. Just click on a palette color and choose your desired color value at the upper right from the primary colors red, green, and blue.



( ) Screen Text
( ) Screen Background
[✓ Popup Text]
( ) Popup Background

Selected Color Values
Red: 0
Green: 128
Blue: 128

Selected Screen Colors

```
C:\WINDOWS> dir
SYSTEM          <DIR>       10-01-99    5:0
SYSTEM32        <DIR>       10-01-99    5:0
```

Selected Popup Colors

```
C:\WINDOWS> dir
SYSTEM          <DIR>       10-01-99    5:0
SYSTEM32        <DIR>       10-01-99    5:0
```

Figure 1.8: Select better colors for your console

Directly Assigning Modifications in PowerShell

Some of the console configuration can also be done from within PowerShell code. You'll hear more about this later. To give you a quick impression, take a look at this:

```
$host.ui.rawui  (Enter)
$host.ui.rawui.ForegroundColor = "Yellow" (Enter)
$host.ui.rawui.WindowTitle = "My Console" (Enter)
```

These changes will only be temporary. Once you close and re-open PowerShell, the changes are gone. You would have to include these lines into one of your "profile scripts," which run every time you launch PowerShell, to make them permanent. You can read more about this in Chapter 10.

Saving Changes

Once you've successfully specified all your settings in the dialog box, you can close the dialog box. If you're using Windows Vista, all changes will be saved immediately, and when you start PowerShell the next time, your new settings will already be in effect. You may need Admin rights to save settings if you launched PowerShell with a link in your start menu that applies for all users.

If you're using Windows XP, you'll see an additional window and a message asking you whether you want to save changes temporarily (Apply properties to current window only) or permanently (Modify shortcut that started this window).

Piping and Routing

You may want to view the information page by page or save it in a file since some commands output a lot of information.

Piping: Outputting Information Page by Page

The pipe command *more* outputs information screen page by screen page. You will need to press a button (like Space) to continue to the next page.

Piping uses the vertical bar (|). The results of the command to the left of the pipe symbol are then fed into the command on the right side of the pipe symbol. This kind of piping is also known in PowerShell as the "pipeline":

```
Get-Process | more (Enter)
```

You can press (Ctrl)+(C) to stop output. Piping also works with other commands, not just *more*. For example, if you'd like to get a sorted directory listing, pipe the result to Sort-Object and specify the columns you would like to sort:

```
dir | Sort-Object -property Length, Name (Enter)
```

You'll find more background information on piping as well as many useful examples in Chapter 5.

Redirecting: Storing Information in Files

If you'd like to redirect the result of a command to a file, you can use the redirection symbol ">":

```
Help > help.txt  (Enter)
```

The information won't appear in the console but will instead be redirected to the specified file. You can then open the file.

However, opening a file in PowerShell is different from opening a file in the classic console:

```
help.txt (Enter)

  The term "help.txt" is not recognized as a cmdlet, function,
  operable program, or script file. Verify the term and try again.
  At line:1 character:8
  + help.txt <<<<
```

If you only specify the file name, PowerShell will look for it in all folders listed in the PATH environment variable. So to open a file, you will have to specify its absolute or relative path name. For example:

```
.\help.txt (Enter)
```

Or, to make it even simpler, you can use AutoComplete and hit (Tab) after the file name:

```
help.txt(Tab)
```

The file name will automatically be completed with the absolute path name, and then you can open it by pressing (Enter):

```
& "C:\Users\UserA\help.txt" (Enter)
```

You can also append data to an existing file. For example, if you'd like to supplement the help information in the file with help on native commands, you can attach this information to the existing file with the redirection symbol ">>":

```
Cmd /c help >> help.txt (Enter)
```

If you'd like to directly process the result of a command, you won't need traditional redirection at all because PowerShell can also store the result of any command to a variable:

```
$result = Ping 10.10.10.10
$result

  Reply from 10.10.10.10: bytes=32 time<1ms TTL=128
  Reply from 10.10.10.10: bytes=32 time<1ms TTL=128
  Reply from 10.10.10.10: bytes=32 time<1ms TTL=128
  Reply from 10.10.10.10: bytes=32 time<1ms TTL=128
  Ping statistics for 10.10.10.10:
      Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
  Approximate round trip times in milli-seconds:
      Minimum = 0ms, Maximum = 0ms, Average = 0ms
```

Variables are universal data storage and variable names always start with a "$". You'll find out more about variables in Chapter 3.

Summary

PowerShell is an optional component for Windows XP and better. You will have to download and install PowerShell before using it. Beginning with Windows Server 2008, PowerShell is included with Windows by default. It still needs to be enabled in Windows software feature list. You will find PowerShell, like any other program, in the start menu below "All Programs." It is located in the program folder *Windows PowerShell 1.0*. The program file name is "powershell.exe."

PowerShell is a basic console program that relies heavily on text input. There are plenty of special keys listed in Table 1.1.

Key	**Meaning**
(Alt)+(F7)	Deletes the current command history
(PgUp), (PgDn)	Display the first (PgUp) or last (PgDn) command you used in current session
(Enter)	Send the entered lines to PowerShell for execution
(End)	Moves the editing cursor to the end of the command line
(Del)	Deletes the character to the right of the insertion point
(Esc)	Deletes current command line
(F2)	Moves in current command line to the next character corresponding to specified character
(F4)	Deletes all characters to the right of the insertion point up to specified character
(F7)	Displays last entered commands in a dialog box
(F8)	Displays commands from command history beginning with the character that you already entered in the command line
(F9)	Opens a dialog box in which you can enter the number of a command from your command history to return the command. (F7) displays numbers of commands in

	command history
(Left arrow), (Right arrow)	Move one character to the left or right respectively
(Arrow up), (Arrow down), (F5), (F8)	Repeat the last previously entered command
(Home)	Moves editing cursor to beginning of command line
(Backspace)	Deletes character to the left of the insertion point
(Ctrl)+(C)	Cancels command execution
(Ctrl)+(End)	Deletes all characters from current position to end of command line
(Ctrl)+(Arrow left), (Ctrl)+(Arrow right)	Move insertion point one word to the left or right respectively
(Ctrl)+(Home)	Deletes all characters of current position up to beginning of command line
(Tab)	Automatically completes current entry, if possible

Table 1.1: Important keys and their meaning in the PowerShell console

You will find that the keys (Arrow up), which repeats the last command, and (Tab), which completes the current entry, are particularly useful. By hitting (Enter), you complete an entry and send it to PowerShell. If PowerShell can't understand a command, an error message appears highlighted in red stating the possible reasons for the error. Two special commands are *cls* (deletes the contents of the console) and *exit* (ends PowerShell).

You can use your mouse to select information in the console and copy it to the Clipboard by pressing (Enter) or by right-clicking when you have turned on the QuickEdit mode. With QuickEdit mode turned off, you will have to right-click inside the console and then select *Mark* in a context menu.

The basic settings of the console—QuickEdit mode as well as colors, fonts, and font sizes—can be customized in the properties window of the console. This can be accessed by right-clicking the icon to the far left in the title bar of the console window. In the dialog box, select *Properties*.

Along with the commands, a number of characters in the console have special meanings as you have already become acquainted with three of them:

- **Piping:** The vertical bar "|" symbol pipes the results of a command to the next. When you pipe the results to the command *more*, the screen output will be paused once the screen is full, and continued when you press a key.
- **Redirection:** The symbol ">" redirects the results of a command to a file. You can then open and view the file contents. The symbol ">>" appends information to an existing file.

CHAPTER 2.

Interactive PowerShell

PowerShell has two faces: interactivity and script automation. In this chapter, you will first learn how to work with PowerShell interactively. Then, we will take a look at PowerShell scripts.

Topics Covered:

PowerShell as a Calculator

You can use the PowerShell console to execute arithmetic operations the same way you would with a calculator. Just enter a math expression and PowerShell will give you the result:

```
2+4 (Enter)
```

```
    6
```

You can use all of the usual basic arithmetic operations. Even parentheses will work just the way they do when you use your pocket calculator:

```
  (12+5) * 3 / 4.5 (Enter)

    11.3333333333333
```

note Parentheses play a special role in PowerShell as they always works from the inside out: the results inside the parentheses are produced before evaluating the expressions outside of the parentheses, i.e. (2*2)*2 = 4*2. For example, operations performed within parentheses have priority and ensure that multiplication operations do not take precedence over addition operations. Parentheses are also important when using PowerShell commands, as you'll discover in upcoming chapters. For example, you could list the contents of subdirectories with the *dir* command and then determine the number of files in a folder by enclosing the *dir* command in parentheses.

```
  (Dir *.txt).Count (Enter)

    12
```

Using a comma instead of a decimal point seems to return the wrong result:

```
  4,3 + 2 (Enter)

    4
    3
    2
```

In the example above, PowerShell simply displayed the numbers again. The comma always creates an array. The important thing to remember is that the decimal point is always a point and not a comma in PowerShell.

Calculating with Number Systems and Units

The next arithmetic problem is a little unusual.

```
  4GB / 720MB (Enter)

    5.68888888888889
```

The example above calculates how many CD-ROMs can be stored on a DVD. PowerShell supports units like kilobyte, megabyte, and gigabyte. Just make sure you do not use a space between number and unit.

```
1mb (Enter)

  1048576
```

important The units *KB*, *MB*, and *GB* can be upper or lower case—how you write them doesn't matter to PowerShell. However, white space characters do matter. Units of measure must directly follow the number and must not be separated from it by a space. Otherwise, PowerShell will interpret the unit as a new command.

Take a look at the following command line:

```
12 + 0xAF (Enter)

  187
```

PowerShell can easily understand hexadecimal values: simply prefix the number with "0x":

```
0xAFFE (Enter)

  45054
```

Here is a quick summary:

- **Operators:** Arithmetic problems can be solved with the help of operators. Operators evaluate the two values to the left and the right. For basic operations, a total of five operators are available, which are also called "arithmetic operators" (Table 2.1).
- **Brackets:** Brackets group statements and ensure that expressions in parentheses are evaluated first.
- **Decimal point:** Fractions use a point as decimal separator (never a comma).
- **Comma:** Commas create arrays and so are irrelevant for normal arithmetic operations.
- **Special conversions:** Hexadecimal numbers are designated by the prefix "0x", which ensures that they are automatically converted into decimal values. If you add one of the KB, MB, or GB units to a number, the number will be multiplied by the unit. White space characters aren't allowed between numbers and values.
- **Results and formats:** Numeric results are always returned as decimal values. If you'd like to see the results presented in a different way, use a format operator like *-f*, which will be discussed in detail later in this book.

Operator	Description	example	result
+	**Adds two values**	**5 + 4.5**	**9.5**

		2gb + 120mb	2273312768
		0x100 + 5	261
		"Hello " + "there"	"Hello there"
-	Subtracts two values	5 - 4.5	0.5
		12gb - 4.5gb	8053063680
		200 - 0xAB	29
*	Multiplies two values	5 * 4.5	22.5
		4mb * 3	12582912
		12 * 0xC0	2304
		"x" * 5	"xxxxx"
/	Divides two values	5 / 4.5	1.11111111111111
		1mb / 30kb	34.1333333333333
		0xFFAB / 0xC	5454,25
%	Supplies the rest of division	5%4.5	0.5

Table 2.1: Arithmetic operators

Executing External Commands

PowerShell can also launch external programs in very much the same way the classic console does. For example, if you want to examine the settings of your network card, enter the command *ipconfig* —it works in PowerShell the same way it does in the traditional console:

```
Ipconfig

  Windows IP Configuration
  Wireless LAN adapter Wireless Network Connection:

    Connection-specific DNS Suffix:
     Connection location IPv6 Address  . : fe80::6093:8889:257e:8d1%8
     IPv4 address  . . . . . . . . . . . : 192.168.1.35
     Subnet Mask  . . . . . . . . . . . : 255.255.255.0
     Standard Gateway . . . . . . . . . . : 192.168.1.1
```

This following command enables you to verify if a Web site is online and tells you the route the data packets are sent between a Web server and your computer:

```
Tracert powershell.com

  Trace route to powershell.com [74.208.54.218] over a maximum of 30 hops:
    1     12 ms      7 ms     11 ms  TobiasWeltner-PC [192.168.1.1]
    2     15 ms     16 ms     16 ms  dslb-088-070-064-001.pools.arcor-ip.net
    3     15 ms     16 ms     16 ms  han-145-254-11-105.arcor-ip.net
    (...)
   17    150 ms    151 ms    152 ms  vl-987.gw-ps2.slr.lxa.oneandone.net
   18    145 ms    145 ms    149 ms  ratdog.info
```

note

You can execute any Windows programs. Just type *notepad* (Enter) or *explorer* (Enter).

There's a difference between text-based commands like *ipconfig* and Windows programs like *Notepad*. Text-based commands are executed synchronously, and the console waits for the commands to complete. Windows-based programs are executed asynchronously. Press (Ctrl)+(C) to cancel a text-based command, which may take longer than expected and is blocking the console.

To clear the console screen type *cls* (Enter).

Starting the "Old" Console

To temporarily switch back to the "old" console, simply enter *cmd* (Enter). Since the old console is just another text-based command, you can easily launch it from within PowerShell. To leave the old console, type *exit* (Enter). Even PowerShell can be closed by entering *exit*. Most text-based commands use exit to quit. Occasionally, the command *quit* is required in commands instead of *exit*.

Discovering Useful Console Commands

The *cmd* command can be used for just one command when you specify the parameter */c*. This is useful for invoking an old console command like *help*. This command has no external program that you can access directly from PowerShell, it's only available inside the classic console. Using this command will return a list of many other useful external console commands.

```
Cmd /c Help
```

```
  For more information on a specific command, type HELP command-name
  ASSOC    Displays or modifies file extension associations.
  AT       Schedules commands and programs to run on a computer.
  ATTRIB   Displays or changes file attributes.
  BREAK    Sets or clears extended CTRL+C checking.
  CACLS    Displays or modifies access control lists (ACLs) of files.
  CALL     Calls one batch program from another.
  CD       Displays the name of or changes the current directory.
  CHCP     Displays or sets the active code page number.
  CHDIR    Displays the name of or changes the current directory.
  CHKDSK   Checks a disk and displays a status report.
  CHKNTFS  Displays or modifies the checking of disk at boot time.
  CLS      Clears the screen.
  CMD      Starts a new instance of the Windows command interpreter.
  COLOR    Sets the default console foreground and background colors.
  COMP     Compares the contents of two files or sets of files.
  COMPACT  Displays or alters the compression of files on NTFS
           partitions.
  CONVERT  Converts FAT volumes to NTFS.  You cannot convert the
           current drive.
  COPY     Copies one or more files to another location.
  DATE     Displays or sets the date.
  DEL      Deletes one or more files.
  DIR      Displays a list of files and subdirectories in a directory.
  DISKCOMP Compares the contents of two floppy disks.
  DISKCOPY Copies the contents of one floppy disk to another.
  DOSKEY   Edits command lines, recalls Windows commands, and creates
           macros.
  ECHO     Displays messages, or turns command echoing on or off.
  ENDLOCAL Ends localization of environment changes in a batch file.
  ERASE    Deletes one or more files.
  EXIT     Quits the CMD.EXE program (command interpreter).
  FC       Compares two files or sets of files, and displays the
           differences between them.
  FIND     Searches for a text string in a file or files.
```

```
FINDSTR  Searches for strings in files.
FOR      Runs a specified command for each file in a set of files.
FORMAT   Formats a disk for use with Windows.
FTYPE    Displays or modifies file types used in file extension
         associations.
GOTO     Directs the Windows command interpreter to a labeled line
         in a batch program.
GRAFTABL Enables Windows to display an extended character set in
         graphics mode.
HELP     Provides Help information for Windows commands.
IF       Performs conditional processing in batch programs.
LABEL    Creates, changes, or deletes the volume label of a disk.
MD       Creates a directory.
MKDIR    Creates a directory.
MODE     Configures a system device.
MORE     Displays output one screen at a time.
MOVE     Moves one or more files from one directory to another
         directory.
PATH     Displays or sets a search path for executable files.
PAUSE    Suspends processing of a batch file and displays a message.
POPD     Restores the previous value of the current directory saved
         by PUSHD.
PRINT    Prints a text file.
PROMPT   Changes the Windows command prompt.
PUSHD    Saves the current directory then changes it.
RD       Removes a directory.
RECOVER  Recovers readable information from a bad or defective disk.
REM      Records comments (remarks) in batch files or CONFIG.SYS.
REN      Renames a file or files.
RENAME   Renames a file or files.
REPLACE  Replaces files.
RMDIR    Removes a directory.
SET      Displays, sets, or removes Windows environment variables.
SETLOCAL Begins localization of environment changes in a batch file.
SHIFT    Shifts the position of replaceable parameters in batch
         files.
SORT     Sorts input.
START    Starts a separate window to run a specified program or
         command.
SUBST    Associates a path with a drive letter.
TIME     Displays or sets the system time.
TITLE    Sets the window title for a CMD.EXE session.
TREE     Graphically displays the directory structure of a drive or
         path.
TYPE     Displays the contents of a text file.
VER      Displays the Windows version.
VERIFY   Tells Windows whether to verify that your files are written
         correctly to a disk.
VOL      Displays a disk volume label and serial number.
XCOPY    Copies files and directory trees.
```

You can use all of the above commands in your PowerShell console. To try this, pick some commands from the list. For example:

```
Cmd /c help vol
```

important

As an added safety net, you should run PowerShell without administrator privileges when experimenting with new commands. That will protect you against mistakes, because most dangerous commands can no longer be executed without administrator rights:

```
defrag c:

  You must have Administrator privileges to defragment a
  volume.
  Use an administrator command line and then run the program
  again.
```

If you must use admin privileges and have enabled User Account Control on Windows Vista, remember to start your PowerShell explicitly with administrator rights. To do this, right-click *PowerShell.exe* and in the context menu, select *Run as Administrator*.

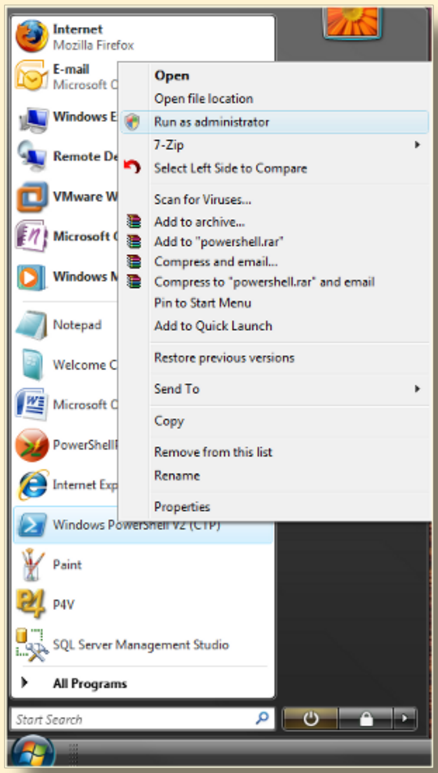


Figure 2.1: Run PowerShell as administrator.

(Run without administrator privileges whenever possible)

Security Restrictions at Program Start

Strangely enough, it seems that some programs can't be launched from PowerShell. While you can launch *notepad*, you cannot launch *wordpad*:

```
wordpad

  The term "wordpad" is not recognized as a cmdlet, function,
  operable program or script file. Verify the term and try again.
  At line:1 char:7
  + wordpad <<<<
```

PowerShell always needs to know where the program is stored. So, if you know the exact path name of Wordpad, PowerShell launches Wordpad after all - almost:

```
C:\programs\Windows NT\accessories\wordpad.exe

  The term "C:\programs\Windows" is not recognized as a
  cmdlet, function, operable program or script file.
  Verify the term and try again.
  At line:1 char:21
  + C:\programs\Windows  <<<< NT\accessories\wordpad.exe
```

Because the path name includes white space characters and because PowerShell interprets white space characters as separators, PowerShell is actually trying to start the program *C:\programs\Windows*. An error message is generated because this path doesn't exist. If path names include spaces, the path must be enclosed in quotation marks. But that causes another problem:

```
"C:\programs\Windows NT\accessories\wordpad.exe"

  C:\programs\Windows NT\accessories\wordpad.exe
```

PowerShell treats text in quotation marks as a string and immediately returns this string. To ensure that PowerShell executes the text in the quotation marks, type an ampersand in front of it:

```
& "C:\programs\Windows NT\accessories\wordpad.exe"
```

Finally, WordPad successfully starts. Hmmm. Wouldn't it be easier to switch from the current subdirectory to the subdirectory where the program we're looking for is located?

```
Cd "C:\programs\Windows NT\accessories"
wordpad.exe

  The term "wordpad" is not recognized as a cmdlet,
  function, operable program or script file.
  Verify the term and try again.
  At line:1 char:11
  + wordpad.exe <<<<
```

This results in another error because PowerShell requires a relative or absolute path. The absolute path name is the complete path while a relative path name always refers to the current directory. To launch a program in your current subdirectory, you use this relative path:

```
.\wordpad.exe
```

Trustworthy Subdirectories

PowerShell distinguishes between trustworthy folders and all other folders. You won't need to provide the path name or append the file extension to the command name if the program is located in a trustworthy folder. Commands like *ping* or *ipconfig* work as-is because they are in located a trustworthy folder, while the program in our last example, *WordPad*, is not.

The Windows environment variable *Path* determines whether a folder is trustworthy or not. All folders listed in this environment variable are treated as "trustworthy" by PowerShell. You could put all your important programs in one of the folders listed in the environment variable *Path*. You can find out this list by entering:

```
$env:Path

  C:\Windows\system32;C:\Windows;C:\Windows\System32\Wbem;C:\program
  Files\Softex\OmniPass;C:\Windows\System32\WindowsPowerShell\v1.0\;c
  :\program Files\Microsoft SQL Server\90\Tools\binn\;C:\program File
  s\ATI Technologies\ATI.ACE\Core-Static;C:\program Files\MakeMsi\;C:
  \program Files\QuickTime\QTSystem\
```

note

You'll find more on variables as well as special environment variables in the next chapter.

As a clever alternative, you can add other folders containing important programs to your *Path* environment variables, such as:

```
$env:path += ";C:\programs\Windows NT\accessories"
wordpad.exe
```

After this change, you can suddenly launch *WordPad* just by entering its program name. Note that your change to the environment variable *Path* is valid only as long as PowerShell is running. Once you end PowerShell, your modification is discarded. So, if you'd like to permanently extend *Path*, you need to add the line for the extension to one of your profile scripts. Profile scripts start automatically when PowerShell starts and their purpose is to customize your PowerShell environment. You read more about profile scripts in Chapter 10.

- **Programs in special subdirectories:** You can simply enter the program name to launch the program if the program is located in one of the special folders specified in the *Path* environment variable. Almost all relevant tools can be launched that way.

- **Specifying a path:** You must tell the console where it is if the program is located somewhere else. To do so, specify the absolute or relative path name of the program.
- **Watch out for white space characters:** if white space characters occur in path names, enclose the entire path in quotes so that PowerShell doesn't interpret white space characters as separators. It doesn't matter whether you use double quotation marks ("") or single quotation marks (' '); you just have to be consistent. Stick to single quotes. For example, PowerShell "resolves" text in double quotation marks, replacing variables with their values.
- **The "&" changes string into commands:** PowerShell doesn't treat text in quotes as a command. Prefix string with "&" to actually execute it. The "&" symbol allows you to execute any string just as if you had entered the text directly on the command line.

```
& ("note" + "pad")
```

tip

If you have to enter a very long path names, remember (Tab), the key for automatic completion:

```
C:\(Tab)
```

Press (Tab) again and again until the suggested subdirectory is the one you are seeking. Add a "\" and press (Tab) once again in order to specify the next subdirectory.

The moment a white space character turns up in a path, AutoComplete also puts the path in quotation marks and inserts an "&" before it. However, if you want to add further subdirectories, you must first remove the last quotation mark with (Backspace).

Cmdlets: "Genuine" PowerShell Commands

PowerShells internal commands are called 'cmdlets'. The "mother" of all cmdlets is called *Get-Command*:

```
Get-Command -commandType cmdlet
```

It retrieves a list of all available cmdlets. Cmdlet names always consist of an action (verb) and something that is acted on (noun). This naming convention helps you to find the right command. Let's take a look at how the system works.

If you're looking for a command for a certain task, you should first select the action that best describes the task. There are relatively few actions that the strict PowerShell naming conditions permit (Table 2.2). If you know that you want to obtain something, the proper action is "get." That already gives you the first part of the command name, and all you have to do now is to take a look at a list of commands that are likely candidates:

```
Get-Command -verb get

  CommandType   Name                   Definition
```

```
-----------  ----                ----------
cmdlet       Get-Acl             Get-Acl [[-Path] <String[]>] [-A...
cmdlet       Get-Alias           Get-alias [[-Name] <String[]>] [...
cmdlet       Get-Authenticode    Get-AuthenticodeSignature [-File...
             Signature
cmdlet       Get-ChildItem       Get-ChildItem [[-Path] <String[]...
cmdlet       Get-Command         Get-Command [[-ArgumentList] <Ob...
cmdlet       Get-Content         Get-Content [-Path] <String[]> [...
cmdlet       Get-Credential      Get-Credential [-Credential] <PS...
cmdlet       Get-Culture         Get-Culture [-Verbose] [-Debug] ...
cmdlet       Get-Date            Get-Date [[-Date] <DateTime>] [-...
cmdlet       Get-EventLog        Get-EventLog [-LogName] <String>...
cmdlet       Get-Execution       Get-ExecutionPolicy [-Verbose] [...
             Policy
cmdlet       Get-Help            Get-Help [[-Name] <String>] [-Ca...
cmdlet       Get-History         Get-History [[-Id] <Int64[]>] [[...
cmdlet       Get-Host            Get-Host [-Verbose] [-Debug] [-E...
cmdlet       Get-Item            Get-Item [-Path] <String[]> [-Fi...
cmdlet       Get-ItemProperty    Get-ItemProperty [-Path] <String...
cmdlet       Get-Location        Get-Location [-PSProvider <Strin...
cmdlet       Get-Member          Get-Member [[-Name] <String[]>] ...
cmdlet       Get-PfxCertificate  Get-PfxCertificate [-FilePath] <...
cmdlet       Get-Process         Get-Process [[-Name] <String[]>]...
cmdlet       Get-PSDrive         Get-PSDrive [[-Name] <String[]>]...
cmdlet       Get-PSProvider      Get-PSProvider [[-PSProvider] <S...
cmdlet       Get-PSSnapin        Get-PSSnapin [[-Name] <String[]>...
cmdlet       Get-Service         Get-Service [[-Name] <String[]>]...
cmdlet       Get-TraceSource     Get-TraceSource [[-Name] <String...
cmdlet       Get-UICulture       Get-UICulture [-Verbose] [-Debug...
cmdlet       Get-Unique          Get-Unique [-InputObject <PSObje...
cmdlet       Get-Variable        Get-Variable [[-Name] <String[]>...
cmdlet       Get-WmiObject       Get-WmiObject [-Class] <String> ...
```

As you see, the relevant cmdlet *Get-Command* comes from the "get" group.

Action	**Description**
Add	Add
Clear	Delete
Compare	Compare
Convert	Convert
Copy	Copy

Export	Export
Format	Format
Get	Acquire
Group	Group
Import	Import
Measure	Measure
Move	Move
New	Create new
Out	Output
Read	Read
Remove	Remove
Rename	Rename
Resolve	Resolve
Restart	Restart
Resume	Resume
Select	Select
Set	Set
Sort	Sort
Split	Split

Start	Start
Stop	Stop
Suspend	Suspend
Tee	Split up
Test	Test
Trace	Trace
Update	Update
Write	Write

Table 2.2: The most important standard actions and their descriptions

You can look up help for any cmdlet using *Get-Help*:

```
Get-Help Get-Command -detailed
```

You can easily discover commands for certain actions because *Get-Command* also allows wildcards:

```
Get-Command *help* -CommandType cmdlet

  CommandType  Name      Definition
  -----------  ----      ----------
  cmdlet       Get-Help  Get-Help [[-Name] <String>] [-Category...
```

Using Parameters

Parameters add information so a cmdlet knows what to do. Once again, *Get-Help* will show you which parameter are supported by any given cmdlet. For example, the cmdlet *Get-ChildItem* lists the contents of the current subdirectory. The contents of the current folder will be listed if you enter the cmdlet without additional parameters:

```
Get-ChildItem
```

For example, if you'd prefer to get a list of the contents of another subdirectory, you should enter the subdirectory name after the cmdlet:

```
Get-ChildItem c:\windows
```

You can use *Get-Help* to output full help on *Get-ChildItem* to find out which parameters are supported:

```
Get-Help Get-ChildItem -full
```

This will give you comprehensive information as well as several examples. Of particular interest is the "Parameters" section:

-path <string[]>

Specifies a path to one or more locations. Wildcards are permitted. The default location is the current directory (.).

Required?	false
Position?	1
Default value	<NOTE: if not specified uses the Current location>
Accept pipeline input?	true (ByValue, ByPropertyName)
Accept wildcard characters?	true

-include <string[]>

Retrieves only the specified items. The value of this parameter qualifies the Path parameter. Enter a path element or pattern, such as "*.txt". Wildcards are permitted.

The Include parameter is effective only when the command includes the Recurse parameter or the path leads to the contents of a directory, such as C:\Windows\*, where the wildcard character specifies the contents of the C:\Windows directory.

Required?	false
Position?	named
Default value	
Accept pipeline input?	false

Accept wildcard characters?	true

-exclude <string[]>

Omits the specified items. The value of this parameter qualifies the Path parameter. Enter a path element or pattern, such as "*.txt". Wildcards are permitted.

This parameter does not work properly in this cmdlet.

Required?	false
Position?	named
Default value	
Accept pipeline input?	false
Accept wildcard characters?	true

-filter <string>

Specifies a filter in the provider's format or language. The value of this parameter qualifies the Path parameter. The syntax of the filter, including the use of wildcards, depends on the provider. Filters are more efficient than other parameters, because the provider applies them when retrieving the objects, rather than having Windows PowerShell filter the objects after they are retrieved.

Required?	false
Position?	2
Default value	
Accept pipeline input?	false
Accept wildcard characters?	true

-name <SwitchParameter>

Retrieves only the names of the items in the locations. If you pipe the output of this command to another command, only the item names are sent.

Required?	false
Position?	named
Default value	False
Accept pipeline input?	false
Accept wildcard characters?	false

-recurse <SwitchParameter>

Gets the items in the specified locations and in all child items of the locations.

Recurse works only when the path points to a container that has child items, such as C:\Windows or C:\Windows\*, and not when it points to items that do not have child items, such as C:\Windows\*.exe.

Required?	false
Position?	named
Default value	False
Accept pipeline input?	false
Accept wildcard characters?	false

-force <SwitchParameter>

Overrides restrictions that prevent the command from succeeding, just so the changes do not compromise security. For example, Force will override the read-only attribute or create directories to complete a file path, but it will not attempt to change file permissions.

Required?	false
Position?	named
Default value	False
Accept pipeline input?	false
Accept wildcard characters?	false

-codeSigningCert <SwitchParameter>

Retrieves only the certificates that have code signing authority. This parameter is valid only when using the Windows PowerShell Certificate provider. For more information, type "get-help about_provider" and "get-help about_signing".

Required?	false
Position?	named
Default value	
Accept pipeline input?	false
Accept wildcard characters?	false

-literalPath <string[]>

Specifies a path to one or more locations. Unlike Path, the value of LiteralPath is used exactly as it is typed. No characters are interpreted as wildcards. If the path includes escape characters, enclose it in single quotation marks. Single quotation marks tell Windows PowerShell not to interpret any characters as escape sequences

Required?	true
Position?	1
Default value	

Accept pipeline input?	true (ByPropertyName)
Accept wildcard characters?	false

<CommonParameters>

This cmdlet supports the common parameters: -Verbose, -Debug, -ErrorAction, -ErrorVariable, and -OutVariable. For more information, type, "get-help about_commonparameters".

Get-ChildItem supports a total of its own eight parameters as well as several *CommonParameters*. Every parameter has a specific name that begins with a hyphen.

Using Named Parameters

Named parameters really work like key-value pairs. You specify the name of a parameter (which always starts with a hyphen), then a space, then the value you want to assign to the parameter. If you ever used VBA (Visual Basic for Applications), it is similar to named parameters there. Let's say you'd like to list all files with the extension **.exe* that are located somewhere in the folder *c:\windows* or in one of its subdirectories, you could use this command:

```
Get-ChildItem -path c:\windows -filter *.exe -recurse -name
```

There are clever tricks to make life easier. You don't have to specify the complete parameter name as it is OK to type out just enough to make clear which parameters you mean:

```
Get-ChildItem -pa c:\windows -fi *.exe -r -n
```

Don't worry: If you are getting too lazy and shorten parameter names too much, PowerShell will report ambiguities and specify the parameter it can no longer assign clearly:

```
Get-ChildItem -pa c:\windows -f *.exe -r -n

   Get-ChildItem : Parameter cannot be processed because
   the parameter name 'f' is ambiguous. Possible matches
   include: -Filter -Force.
   At line:1 char:14
   + Get-ChildItem  <<<< -pa c:\windows -f *.exe -r -n
```

note

You can also turn off parameter recognition. This is necessary in the rare event that an argument reads like a parameter name, and so must be entered in such a way that it is not interpreted as a parameter. So, if you need to output the text "-BackgroundColor" with W*rite-Host*, this will likely result in a conflict. PowerShell would assume that you meant *-BackgroundColor* and notify you that the argument for this parameter is missing.

```
  Write-Host -BackgroundColor

    Write-Host : Missing an argument for parameter
    'BackgroundColor'. Specify a parameter of type
    "System.consoleColor" and try again.
    At line:1 char:27
    + Write-Host -BackgroundColor <<<<
```

You always have the choice of including the text in quotes. Or you can expressly turn off parameter recognition by typing "--". Everything following these two symbols will no longer be recognized as a parameter:

```
  Write-Host "-BackgroundColor"

    -BackgroundColor

  Write-Host -- -BackgroundColor

    -BackgroundColor
```

Switch Parameter

Sometimes, parameters really are no key-value pairs. Whenever a parameter represents a boolean value (true or false), most often it is used as a switch parameter (present or not). So, switch parameters stand for themselves, no values follow. If they're specified, they turn on a certain function. If they're left out, they don't turn on the function. For example, the parameter *-recurse* ensures that *Get-ChildItem* searches not only the *-path* specified subdirectories but all subdirectories. And the switch parameter *-name* makes *Get-ChildItem* output only the names of files (as string rather than rich file and folder objects).

The help on *Get-ChildItem* clearly identifies switch parameters. "<SwitchParameter>" follows the parameter names:

```
    -recurse <SwitchParameter>
            Gets the items in the specified locations and all child
            items of the locations.
    (...)
```

Positional Parameters

Some parameters have fixed positions while others are "named" - you can find out in Help when you look at the cmdlet parameters and check out their "Position" property. Named parameters are easy: they always need to be named so you always have to specify the parameter name, a space, and then the parameter value. Positional parameters work the same but you can also specify them as positional. So when a parameter has a position of 1, the first "unnamed" parameter is assigned to it.

That's why you could have expressed the command we just discussed in one of the following ways:

```
Get-ChildItem c:\windows *.exe -recurse -name
Get-ChildItem -recurse -name c:\windows *.exe
Get-ChildItem -name c:\windows *.exe -recurse
```

In all three cases, PowerShell identifies and eliminates the named arguments *-recurse* and *-name* first because they are clearly specified. The remaining are arguments are "unnamed" and need to be assigned based on their position:

```
Get-ChildItem c:\windows *.exe
```

The parameter *-path* has the position *1*, and no value has yet been assigned to it. So, PowerShell attaches the first remaining argument to this parameter.

```
-path <string[]>
        Specifies a path to one or more locations. Wildcards are
        permitted. The default location is the current directory (.).
        Required?                    false
        Position?                    1
        Standard value used          <NOTE: if not specified uses
                                     the Current location>
        Accept pipeline input?       true (ByValue, ByPropertyName)
        Accept wildcard characters?  true
```

The parameter -filter has the position 2. Consequently, it is assigned the second remaining argument. The position specification makes it easier to use a cmdlet because you don't have to specify any parameter names for the most frequently and commonly used parameters.

Here is a tip: In daily interactive PowerShell scripting, you want short and fast commands so use aliases, positional parameters, and abbreviated parameter names. Once you write PowerShell scripts, you should not use these shortcuts and instead use the true cmdlet names and stick to fully named parameters. One reason is that scripts should be portable and not depend on specific aliases you may have defined. Second, scripts are more complex and need to be as readable and understandable as possible. Named parameters help other people better understand what you are doing.

Common Parameters

Cmdlets also support a set of generic "CommonParameters":

```
<CommonParameters>
```

```
This cmdlet supports the common parameters: -Verbose,
-Debug, -ErrorAction, -ErrorVariable, and -OutVariable.
For more information, type "get-help about_commonparameters".
```

These parameters are called "common" because they are permitted for (nearly) all cmdlets and behave the same way.

Common Parameter	**Type**	**Description**
-Verbose	Switch	Generates as much information as possible. Without this switch, the cmdlet restricts itself to displaying only essential information
-Debug	Switch	Outputs additional warnings and error messages that help programmers find the causes of errors. You can find more information in Chapter 11.
-ErrorAction	Value	Determines how the cmdlet responds when an error occurs. Permitted values: *NotifyContinue:* reports error and continues (default) *NotifyStop:* reports error and stops *SilentContinue:* displays no error message, continues *SilentStop:* displays no error message, stops *Inquire:* asks how to proceed You can find more information in Chapter 11.
-ErrorVariable	Value	Name of a variable in which in the event of an error information about the error is stored. You can find more information in Chapter 11.

-OutVariable	Value	Name of a variable in which the result of a cmdlet is to be stored. This parameter is usually superfluous because you can directly assign the value to a variable. The difference is that it will no longer be displayed in the console if you assign the result to a variable.
		`$result = Get-ChildItem`
		It will be output to the console and stored in a variable if you assign the result additionally to a variable:
		`Get-ChildItem -OutVariable result`

Table 2.3: Common parameters in effect for (nearly) all cmdlets

Aliases: Giving Commands Other Names

Cmdlet names with their verb-noun convention are very systematic, yet not very practical. In every day admin life, you want short and familiar commands. This is why PowerShell has a built-in alias system as it comes with a lot of predefined aliases. This is why in PowerShell, both Windows admins and UNIX admins can list folder contents. There are predefined aliases called "dir" and "ls" which both point to the PowerShell cmdlet Get-ChildItem.

```
Get-ChildItem c:\
Dir c:\
ls c:\
```

So, aliases have two important tasks in PowerShell:

- **Historical:** New commands are designed to be accessed under old conventional names to facilitate the transition to PowerShell
- **Comfort:** Frequently used commands are meant to be accessed over short and concise commands

Resolving Aliases

Use these lines if you'd like to know what "genuine" command is hidden in an alias:

```
$alias:Dir

  Get-ChildItem

$alias:ls

  Get-ChildItem
```

$alias:Dir lists the element *Dir* of the drive *alias:*. That may seem somewhat surprising because there is no drive called *alias:* in the classic console. In contrast, PowerShell works with many different virtual drives, and *alias:* is only one of them. If you want to know more, the cmdlet *Get-PSDrive* lists them all. You can also list *alias:* like any other drive with *Dir*. The result would be a list of aliases in their entirety:

```
Dir alias:

  CommandType  Name  Definition
  -----------  ----  ----------
  alias        ac    Add-Content
  alias        asnp  Add-PSSnapin
  alias        clc   Clear-Content
  (...)
```

You can also get the list of aliases using the cmdlet *Get-Alias*. You receive a list of individual alias definitions by using its parameter *-name*:

```
Get-alias -name Dir
Get-ChildItem
```

It's a little more complex to list all aliases for a given cmdlet. Just use the PowerShell pipeline which feeds the result of a command into the next one and chains together commands. The concept of the pipeline will be discussed in detail in Chapter 5. You may not really grasp the significance of the next command until after you've read this chapter. Nevertheless, here it is:

```
Get-Alias | Where-Object {$_.Definition -eq "Get-ChildItem"}
```

Here, the list of aliases that *Get-Alias* generates is fed into the next cmdlet, *Where-Object*. This cmdlet is a pipeline filter and allows only those objects to pass through that meet the specified condition. In this case, the condition is called "$_.Definition -eq 'Get-ChildItem' ". *$_* represents the current pipeline object. The condition checks the *Definition* property in this object, and if it equals the "Get-ChildItem" string, the object can continue to pass through the pipeline. If not, it is filtered out.

```
CommandType  Name  Definition
-----------  ----  ----------
alias        gci   Get-ChildItem
alias        ls    Get-ChildItem
alias        Dir   Get-ChildItem
```

As it turns out, there's even a third alias for *Get-ChildItem* called "*gci*". Generally speaking, PowerShell allows you to find several approaches to the same goal so you could have found the same result by entering:

```
Dir alias: | Out-String -Stream | Select-String "Get-ChildItem"
```

Here, the PowerShell pipeline works with conventional string, not objects. *Out-String* converts the objects that *Dir alias:* generates into string. The parameter *-Stream* makes sure each objects' string representation is immediately forwarded to the next command in the pipeline. *Select-String* filters a string, allowing only a string to pass through that includes the search word you specified.

Don't worry; all the techniques scratched here will be covered in detail in upcoming chapters. Here is another example for you to try out the power of the PowerShell pipeline:

```
Dir alias: | Group-Object definition
```

Here, the individual alias definitions are again fed through the PowerShell pipeline, yet this time the cmdlet *Group-Object* grouped the objects by their definition property. That's why *Group-Object* generates a neatly ordered list of all cmdlets, for which there are shorthand expressions for aliases. In the Group column, you'll find the respective aliases in braces ({}).

```
Count Name                      Group
----- ----                      -----
    1 Add-Content               {ac}
    1 Add-PSSnapin              {asnp}
    1 Clear-Content             {clc}
```

```
1 Clear-Item                {cli}
1 Clear-ItemProperty        {clp}
1 Clear-Variable            {clv}
3 Copy-Item                 {cpi, cp, copy}
1 Copy-ItemProperty         {cpp}
1 Convert-Path              {cvpa}
1 Compare-Object            {diff}
1 Export-Alias              {epal}
1 Export-Csv                {epcsv}
1 Format-Custom             {fc}
1 Format-List               {fl}
2 ForEach-Object            {foreach, %}
1 Format-Table              {ft}
1 Format-Wide               {fw}
1 Get-Alias                 {gal}
3 Get-Content               {gc, cat, type}
3 Get-ChildItem             {gci, ls, Dir}
1 Get-Command               {gcm}
1 Get-PSDrive               {gdr}
3 Get-History               {ghy, h, history}
1 Get-Item                  {gi}
2 Get-Location              {gl, pwd}
1 Get-Member                {gm}
1 Get-ItemProperty          {gp}
2 Get-Process               {gps, ps}
1 Group-Object              {group}
1 Get-Service               {gsv}
1 Get-PSSnapin              {gsnp}
1 Get-Unique                {gu}
1 Get-Variable              {gv}
1 Get-WmiObject             {gwmi}
1 Invoke-Expression         {iex}
2 Invoke-History            {ihy, r}
1 Invoke-Item               {ii}
1 Import-Alias              {ipal}
1 Import-Csv                {ipcsv}
3 Move-Item                 {mi, mv, move}
1 Move-ItemProperty         {mp}
1 New-Alias                 {nal}
2 New-PSDrive               {ndr, mount}
1 New-Item                  {ni}
1 New-Variable              {nv}
1 Out-Host                  {oh}
1 Remove-PSDrive            {rdr}
6 Remove-Item               {ri, rm, rmdir, del...}
2 Rename-Item               {rni, ren}
1 Rename-ItemProperty       {rnp}
1 Remove-ItemProperty       {rp}
1 Remove-PSSnapin           {rsnp}
1 Remove-Variable           {rv}
1 Resolve-Path              {rvpa}
1 Set-Alias                 {sal}
1 Start-Service             {sasv}
```

```
1 Set-Content                {sc}
1 Select-Object              {select}
1 Set-Item                   {si}
3 Set-Location               {sl, cd, chdir}
1 Start-Sleep                {sleep}
1 Sort-Object                {sort}
1 Set-ItemProperty           {sp}
2 Stop-Process               {spps, kill}
1 Stop-Service               {spsv}
2 Set-Variable               {sv, set}
1 Tee-Object                 {tee}
2 Where-Object               {where, ?}
2 Write-Output               {write, echo}
2 Clear-Host                 {clear, cls}
1 Out-Printer                {lp}
1 Pop-Location               {popd}
1 Push-Location              {pushd}
```

Creating Your Own Aliases

Anyone can create a new alias, which is a shortcut for another command. The cmdlet *Set-Alias* adds additional alias definitions. You could actually override commands with aliases since aliases have precedence over other commands. Take a look at the next example:

```
Edit
Set-Alias edit notepad.exe
Edit
```

Edit typically launches the console-based Editor program. To exit without completely closing the console window, press (Alt)+(F) and then (X).

If you create a new alias called "Edit" and set it to "notepad.exe", the command *Edit* will be re-programmed. The next time you enter it, PowerShell will no longer run the old Editor program, but the Notepad.

```
$alias:edit
```

Removing—or Permanently Retaining—an Alias

How do you remove aliases? You don't. All new aliases are discarded as soon as you exit PowerShell. All of your own aliases will be gone the next time you start PowerShell. "Built-in" aliases like "dir" and "cd" will still be there.

If you'd like to keep your own aliases permanently, you have the following options:

- **Manually each time:** Set your aliases after every start manually using Set-Alias. That is, of course, rather theoretical.
- **Automated in a profile:** Let your alias be set automatically when PowerShell starts: add your aliases to a start profile. You'll learn how to do this in Chapter 10.

- **Import and export:** You can use the built-in import and export function for aliases.

For example, if you'd like to export all currently defined aliases as a list to a file, enter:

```
Export-Alias
```

Because you haven't entered any file names after *Export-Alias*, the command will ask you what the name are under which you want to save the list. Type in:

alias1 (Enter)

The list will be saved. You can look at the list afterwards and manipulate it. For example, you might want the list to include a few of your own alias definitions:

```
Notepad alias1
```

You can import the list to activate the alias definitions:

```
Import-Alias alias1

  Import-Alias : Alias not allowed because an alias with the
  name "ac" already exists.
  At line:1 char:13
  + Import-Alias  <<<< alias1
```

Import-Alias notifies you that it couldn't create some aliases of the list because these aliases already exist. Specify additionally the option *-Force* to ensure that *Import-Alias* overwrites existing aliases, :

```
Import-Alias alias1 -Force
```

tip You could add the *Import-Alias* instruction to your start profile and specify a permanent path to the alias list. This would make PowerShell automatically read this alias list when it starts. Later, you can add new aliases. Then, it would suffice to update the alias list with *Export-Alias* and to write over the old file. This is one way for you to keep your aliases permanently.

Overwriting Alias Definitions and Deleting Them Manually

You can overwrite aliases with new definitions any time. Just redefine the alias with the cmdlet *Set-Alias*. Use this command if you'd like to remove an alias completely and don't want to wait until you end PowerShell:

```
Del alias:edit
```

This instruction deletes the "Edit" alias. Here, the uniform provider approach becomes evident. The very same "Del" command would allow you to delete files and subdirectories in the file system as well. Perhaps you're already familiar with the command from the classic console:

```
Del C:\garbage.txt
```

pro tip

Here is an example that finds all aliases that point to no valid target, which is a great way of finding outdated or damaged aliases:

```
Get-Alias | ForEach-Object {
  if (!(Get-Command $_.Definition -ea SilentlyContinue)) {$_}}
```

Functions: "Expanded" Aliases

Aliases are simple shortcuts to call commands with another name (shortcut names), or to make the transition to PowerShell easier (familiar names). The arguments of a command can never be included in an alias, though. If you want that, you will need to use functions.

Calling Commands with Arguments

If you find yourself using the command *ping* quite often to verify network addresses, you may want to make this easier by creating a shortcut that not only calls ping.exe, but also appends standard arguments to it. Let's see how you could automate this call:

```
Ping -n 1 -w 100 10.10.10.10
```

Aliases won't work in this case because they can't specify command arguments. Functions can since they are more flexible:

```
function quickping { ping -n 1 -w 100 $args }
quickping 10.10.10.10

  Pinging 10.10.10.10 with 32 bytes of data:
  Reply from 10.10.10.10: bytes=32 time<1ms TTL=128
  Ping statistics for 10.10.10.10:
      Packets: Sent = 1, Received = 1, Lost = 0 (0% loss),
  Approximate round trip times in milli-seconds:
      Minimum = 0ms, Maximum = 0ms, Average = 0ms

Set-Alias qp quickping
qp 10.10.10.10

  Pinging 10.10.10.10 with 32 bytes of data:
  Reply from 10.10.10.10: bytes=32 time<1ms TTL=128
```

```
    Ping statistics for 10.10.10.10:
        Packets: Sent = 1, Received = 1, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 0ms, Average = 0ms
```

Unlike alias definitions, you can specify complex code inside of braces in functions. So, you are no longer limited to just specify a single command, but can also add any argument you want to be part of the call. *$args* in this connection acts as placeholder for the arguments that you assign to the function.

Creating Shortcut Commands

You may have noticed that PowerShell doesn't accept console commands like the following one, which do work in the classic console:

```
Cd..

  The term "Cd.." is not recognized as a cmdlet, function, operable
  program, or script file. Verify the term and try again.
  At line:1 char:14
  + Set-Location.. <<<<
```

The reason is that PowerShell is more strict and needs a space as delimiter between command and argument. *Cd* is an alias and points to the cmdlet *Set-Location.* If you omit a space, PowerShell tried to find a command called "Cd.." and since it can't find one, it outputs an exception. The solution is rather easy: you should define your own "cd.." command by defining a function with that name:

```
function Cd.. { Cd .. }
Cd..
```

The entry Cd.. works immediately because now PowerShell is running your new function. You can add many other shortcuts this way.

note

Functions have exactly the same lifespan as aliases. As soon as you exit PowerShell, it "forgets" all new aliases and functions that you added. If you want to retain your PowerShell functions, you should put them into one of the profile scripts that PowerShell runs automatically when it starts. This is covered in Chapter 10.

Invoking Files and Scripts

To run files (like documents or scripts), PowerShell uses the same rules that apply to executables: either, you specify an absolute or relative path, or the file needs to be located in one of the special trustworthy folders defined in the *Path* environment variable.

```
# Save information on all running processes to HTML file
# (lasts several seconds):
Get-Process | ConvertTo-Html | Out-File test.htm
# File cannot be opened directly:
test.htm

  The term "test.htm" is not recognized as a cmdlet, function,
  operable program, or script file. Verify the term and try again.
  At line:1 char:8
  + test.htm <<<<

# Specify a relative or absolute path name:
.\test.htm
```

Starting Scripts

Scripts and batch files are pseudo-executables as they contain script code that can be executed by a command line interpreter.

Running Batch Files

Batch files are text files with the extension ".bat". They may include all the commands allowed in a classic cmd.exe console. When a batch file is opened, the classic console immediately starts to execute the commands it contains. Let's check it out. First, create this test file:

```
Notepad ping.bat
```

Now enter this text:

```
@echo off
echo An attacker can do dangerous things here
pause
Dir %windir%
pause
Dir %windir%\system
```

Save the text and close Notepad. Your batch file is ready for action. Try to launch the batch file by entering its name:

```
Ping
```

The batch file won't run. Because it has the same name and you didn't specify any IP address or Web site address, the Ping command spits out its internal help message. If you want to launch your batch file, you're going to have to specify either the relative or absolute path name.

```
.\ping
```

Your batch file opens, then immediately run the commands it contains.

PowerShell has just defended a clever attack. If you were using the classic console, you would have been fooled by the attacker. All you have to do is switch over to the classic console and see for yourself:

```
Cmd
Ping 10.10.10.10

  An attacker can do dangerous things here
  Press any key . . .
```

If an attacker had smuggled a batch file named "ping.bat" into your current folder, then the Ping command, harmless though it might seem, could have had catastrophic consequences. A classic console doesn't distinguish between files and commands. It looks *first* in the current folder, finds the batch file, and executes it immediately. Such a mix-up would never happen in the PowerShell console. So, return to your much safer PowerShell environment:

```
Exit
```

Running VBScript Files

VBScript is another popular automation language as its scripts are tagged with the file extension ".vbs". What we have just discussed about batch files also applies to these scripts:

```
Notepad test.vbs
```

Enter this VBScript code in Notepad:

```
  Set wmi = GetObject("winmgmts:")
  Set collection = wmi.ExecQuery("select * from Win32_Process")
  For Each process in collection
    WScript.Echo process.getObjectText_
  Next
```

You should know how to run this script:

```
.\test.vbs (Enter)
```

important

You should first switch the Windows Script Host into the console display before running the script so it will output its results directly within the console. If you don't do this, every output will be shown in its own window and you'll have to manually close each one.

```
Wscript //H:CScript
```

And this is the way to switch it back to Windows display:

```
WScript //H:WScript
```

You can also run your VBS script without switching as a console script by directly specifying the script host you want:

```
CScript test.vbs
```

The script lists all running processes and provides many interesting details on every process. VBScript is a very versatile and powerful automation language, and it's important to show how you can use VBScript files in PowerShell.

Running PowerShell Scripts

PowerShell has its own script files with the file extension ".ps1". While you will learn much more about PowerShell scripts in Chapter 10, you already know enough to write your first script:

```
Notepad test.ps1
```

Enter in Notepad any PowerShell command you like. Everything you've successfully entered in the console up to now is allowed. PowerShell scripts function very much like the batch files of the classic console: if the script is opened later, PowerShell works through everything in your script one step at a time, just as if you had directly entered each line one-by-one in the console.

```
Dir
Get-PSProvider
help Dir
```

Try to bring it to life after you've saved your script:

```
.\test.ps1

  File "C:\Users\UserA\test.ps1" cannot be loaded because the
  execution of scripts is disabled on this system. Please see
  "get-help about_signing" for more details.
  At line:1 char:10
  + .\test.ps1 <<<<
```

You'll probably receive an error message similar to the one in the above example. In PowerShell, all scripts are at first disabled and cannot be started. PowerShell will start scripts only once you enabled them (for which you need admin privileges since a regular user cannot change this setting). You can give your permission by entering *Set-ExecutionPolicy*:

```
Set-ExecutionPolicy RemoteSigned
```

This grants permission to run locally stored PowerShell scripts as scripts from the Internet remain prohibited unless they have a valid signature. The implications of signatures and other security settings will be discussed in Chapter 10. For now, the command described above should be enough for you to experiment with your own PowerShell scripts. To restore the original setting and prohibit PowerShell scripts, you should enter:

```
Set-ExecutionPolicy Default
```

Summary

The PowerShell console runs all kinds of commands interactively: you enter a command, and the console will more or less immediately return the results.

Cmdlets are PowerShell's own internal commands. A cmdlet name always consists of a description of an action (verb), and the object of the action (noun). The cmdlet *Get-Command* will provide a list of all cmdlets. *Get-Help* will also offer information about a particular cmdlet and can also search for cmdlet names when you specify a search phrase and wildcards: Get-Command *Service*

In addition, you can use aliases, functions, and scripts in PowerShell. An alias is a shortcut name for any other command, enabling you to create your own convenient shorthand expressions for commands you use frequently. Functions and scripts combine several PowerShell commands. If you enter a command and execute it by pressing (Enter), PowerShell looks for the command in this order:

- **Alias:** It will first look to see if your command corresponds to an alias. If it does, the command will be executed that the alias designates. You can "overwrite" any other command with an alias by using the cmdlet *Set-Alias* because aliases have highest priority.
- **Function:** If no alias could be found, PowerShell looks next for a function, which resembles an alias, but can consist of many PowerShell instructions. You can wrap commands, including frequently used arguments, in functions.
- **Cmdlet:** If it's not possible to find a function, PowerShell looks for cmdlets, which are internal PowerShell commands that conform to strict naming rules and whose names always consist of a verb and a noun.
- **Application:** PowerShell looks first for a cmdlet, and if it can't find any, it then searches for external commands in the subdirectories specified in the *Path* environment variables. If you'd like to use a command at some other location, then you must specify a relative or absolute path name.
- **Script:** If PowerShell can't find any external commands, it looks next for a script with the file extension ".ps1". However, scripts are executed only when restrictions of the *ExecutionPolicy* are eased, allowing PowerShell scripts to be run.
- **Files:** If no PowerShell scripts are found, PowerShell keeps looking for other files. PowerShell reports an error if your command doesn't match any files.

pro tip

Again, use Get-Command to find out if there are any ambiguities. The next line will list all commands that PowerShell knows that use "ping" as a name.

```
Get-Command ping
```

Type this if you'd like to find out whether there are commands with the same names in differently named categories that conflict:

```
  Get-Command -type cmdlet,function,alias | Group-Object name |
    Where-Object {$_.count -gt 1}
```

CHAPTER 3.

Variables

It is time to combine commands whenever a single PowerShell command can't solve your problem. One way of doing this is by using variables. PowerShell can store results of one command in a variable and then pass the variable to another command.

In addition, variables are rich 'objects' and can do much more than simply store data. In this chapter, we'll explain what variables are and how you can use them to solve complex problems.

Topics Covered:

Your Own Variables

Variables store information temporarily so you can take the information contained in a variable and process it in further steps.

```
# Create variables and assign to values
$amount = 120
$VAT = 0.19
# Calculate:
$result = $amount * $VAT
# Output result
$result

  22.8

# Replace variables in text with values:
$text = "Net amount $amount matches gross amount $result"
$text

  Net amount 120 matches gross amount 142.8
```

PowerShell creates new variables automatically so there is no need to specifically "declare" variables. Simply assign data to a variable. The only thing you need to know is that variable names are always prefixed with a "$".

You can then output the variable content by entering the variable name, or you can merge the variable content into text strings. To do that, just make sure the string is delimited by double-quotes. Single-quoted text will not resolve variables.

Selecting Variable Names

In PowerShell, a variable name always begins with a dollar sign "$". The rest of the name may consist of almost anything you want: letters, numbers, and the underline character. PowerShell variable names are not case sensitive.

There is only one exception: certain special characters have special meaning for PowerShell. While you can still use those special characters in variable names, you will then need to enclose the variable name in braces. The best suggestion is not to use PowerShell's special characters in variable names to avoid braces:

```
# Variable names with special characters belong in braces:
${this variable name is "unusual," but permitted} = "Hello World"
${this variable name is "unusual," but permitted}

  Hello World
```

Assigning and Returning Values

The assignment operator "=" sets a variable to a specified value. You can assign almost anything to a variable, even complete command results:

```
# Temporarily store results of a cmdlet:
$listing = Get-ChildItem c:\
$listing


  Directory: Microsoft.PowerShell.Core\FileSystem::C:\
  Mode                LastWriteTime     Length Name
  ----                -------------     ------ ----
  d----        06.26.2007     15:36            2420
  d----        05.04.2007     21:06            ATI
  d----        08.28.2006     18:22            Documents and settings
  d----        08.08.2007     21:46            EFSTMPWP
  d----        04.28.2007     02:18            perflogs
  (...)

# Temporarily store the result of a legacy external command:
$result = ipconfig
$result

  Windows IP Configuration
  Ethernet adapter LAN Connection:
  Media state
  . . . . . . . . . . . : Medium disconnected
  Connection-specific DNS Suffix:
  Ethernet adapter LAN Connection 2:
  Media state
  . . . . . . . . . . . : Medium disconnected
  Connection-specific DNS Suffix:
  Wireless LAN adapter wireless network connection:
  Media state
  . . . . . . . . . . . : Medium disconnected
  Connection-specific DNS Suffix:
```

Populating Several Variables with Values Simultaneously

Not only can the assignment operator assign values to a single variable, it can set the contents of several variables in one step. For example, you could set a whole series of variables to one shared initial value:

```
# Populate several variables with the same value in one step:
$a = $b = $c = 1
$a

  1

$b

  1

$c

  1
```

Exchanging the Contents of Variables

Now and then you might want to exchange the contents of two variables. In traditional programming languages, that would require several steps:

```
$Value1 = 10
$Value2 = 20
$Temp = $Value1
$Value1 = $Value2
$Value2 = $Temp
```

With PowerShell, swapping variable content is much easier. First of all, you can write several statements in one line if you separate the statements from each other by semi-colon. Second, assignment operators will accept several variables on each side that replace each other:

```
# Exchange variable values:
$Value1 = 10; $Value2 = 20
$Value1, $Value2 = $Value2, $Value1
```

Assigning Different Values to Several Variables

The real trick in the last example is the comma. PowerShell always uses the comma to create a variable array (a variable that holds more than one value). We'll be exploring these arrays in depth in Chapter 4, but it is important for you to know now that the assignment operator also processes arrays. If you state to its left and right an array having the same number of elements, then it will assign the elements of the array on the right side to the elements of the array on the left side. This is a way for you to use a single assignment operator to populate different variables with different values. It can thus simplify the previous example even more:

```
# Populate several variables with the same value in one step:
$Value1, $Value2 = 10,20
$Value1, $Value2 = $Value2, $Value1
```

Overview of Variables in Use

PowerShell keeps a record of all variable assignments, which is accessible via a virtual drive called *variable:*. To see all currently defined variables, you should just output this drive to a list:

```
Dir variable:
```

Don't be surprised to see not only variables you've created yourself, but also many more. The reason: PowerShell also defines variables and calls them "automatic variables." You'll learn more about this soon.

Finding Variables

Using the *variable:* virtual drive makes it easy to find variables by allowing wildcards, just like in the file system. If you'd like to see all the variables whose name begins with the letters "value", try this:

```
Dir variable:value*

  Name                           Value
  ----                           -----
  value2                          20
  value1                          10
```

Dir lists the two variables *$value1* and *$value2* as well as returning their current contents. You can also use the *Dir* parameters *-include* and *-exclude* (the alias for *Get-ChildItem*). The next example uses the *-exclude parameter to* find all the variables that begin with the letters "value" but don't use an "l" in their names:

```
Dir variable: -include value* -exclude *1*

  Name                           Value
  ----                           -----
  value2                          20
```

If you'd like to know which variables currently contain the value *20*, the solution isn't quite so simple, yet it is still doable. It consists of several commands piped together.

```
dir variable: | Out-String -stream | Select-String " 20 "

  value2                          20
  $                               20
```

Here, the output from *Dir* is passed on to *Out-String,* which converts the results of *Dir* into text. The parameter *-stream* ensures that every variable supplied by *Dir* is separately output as text. *Select-String* selects the lines that include the desired value, filtering out the rest. To ensure that only the desired value is found and not other values that contain the number 20 (like 200), white space is added before and after the number 20.

Verify Whether a Variable Exists

To find out whether a variable already exists, you should again do as you would with the file system. Using the cmdlet *Test-Path*, you can verify whether a certain file exists. Similar to files, variables are stored in their own "drive" called *variable:* and every variable has a path name that you can verify with *Test-Path*:

```
# Verify whether the variable $value2 exists:
Test-Path variable:\value2

  True

# verify whether the variable $server exists:
Test-Path variable:\server

  False
```

Whether a variable already exists or not doesn't usually matter. When you assign a value to an existing variable, the new value will simply overwrite the old one. However, sometimes you might want to assign a value only when the variable doesn't exist yet. Also, variables can be write-protected so that you cannot easily overwrite an existing variable.

Deleting Variables

Because variables are deleted automatically as soon as you exit PowerShell, you don't necessarily need to clean them up manually. If you'd like to delete a variable immediately, again, do exactly as you would in the file system:

```
# create a test variable:
$test = 1
# verify that the variable exists:
Dir variable:\te*
# delete variable:
del variable:\test
# variable is removed from the listing:
Dir variable:\te*
```

Using Special Variable Cmdlets

To manage your variables, PowerShell provides you with the five separate cmdlets listed in Table 3.1. You won't need these for everyday tasks because, as you've just seen, the virtual drive *variable:* enables you to perform the most important management tasks just as you do in the file system. Only two of the five cmdlets really offer you new options:

1. *New-Variable* enables you to specify options, such as a description or write protection. This makes a variable into a constant. Set-Variable does the same for existing variables.
2. *Get-Variable* enables you to retrieve the internal PowerShell variables store.

Cmdlet	**Description**	**Example**
Clear-Variable	Clears the contents of a variable, but not the variable itself. The subsequent value of the variable is NULL (empty). If a data or object type is specified for the variable, by using *Clear-Variable* the type of the objected stored in the variable will be preserved.	Clear-Variable a *same as: $a = $null*
Get-Variable	Gets the variable object, not the value in which the variable is stored.	Get-Variable a
New-Variable	Creates a new variable and can set special variable options.	New-Variable value 12
Remove-Variable	Deletes the variable, and its contents, as long as the variable is not a constant or is created by the system.	Remove-Variable a *same as: del variable:\a*
Set-Variable	Resets the value of variable or variable options such as a description and creates a variable if it does not exist.	Set-Variable a 12 *same as: $a = 12*

Table 3.1: Cmdlets for managing variables

Write-Protecting Variables: Creating Constants

Constants store a constant value that cannot be modified. They work like variables with a write-protection.

PowerShell doesn't distinguish between variables and constants. However, it does offer you the option of write-protecting a variable. In the following example, the write-protected variable *$test* is created with a fixed value of 100. In addition, a description is attached to the variable.

```
# Create new variable with description and write-protection:
New-Variable test -value 100 -description `
  "test variable with write-protection" -option ReadOnly
$test

  100
```

```
# Variable contents cannot be modified:
$test = 200

  The variable "test" cannot be overwritten since it is a
  constant or read-only.
  At line:1 char:6
  + $test  <<<< = 200
```

The variable is now write-protected and its value may no longer be changed. You'll receive an error message if you try to change it. You must delete the variable and re-define it if you want to modify its value. Because the variable is write-protected, it behaves like a read-only file. You'll have to specify the parameter *-force* to delete it:

```
del variable:\test -force
$test = 200
```

A write-protected variable can still be modified by deleting it and creating a new copy of it. If you need strong protection like in traditional constants, you should create a variable with the *Constant* option. This will change the variable to a proper constant that may neither be modified nor deleted. Only when you quit PowerShell are constants removed. Variables with the *Constant* option may only be created with *New-Variable*. You'll get an error message if a variable already exists that has the specified name:

```
#New-Variable cannot write over existing variables:
New-Variable test -value 100 -description `
  "test variable with copy protection" -option Constant

  New-Variable : A variable named "test" already exists.
  At line:1 Char:13
  + New-Variable  <<<< test -value 100 -description
  "test variable with copy protection" -option Constant

# If existing variable is deleted, New-Variable can create
# a new one with the "Constant" option:
del variable:\test -force
New-Variable test -value 100 -description `
  "test variable with copy protection" `
  -option Constant
# variables with the "Constant" option may neither be
# modified nor deleted:
del variable:\test -force

  Remove-Item : variable "test" may not be removed since it is a
  constant or write-protected. If the variable is write-protected,
  carry out the process with the Force parameter.
  At line:1 Char:4
  + del  <<<< variable:\test -force
```

You can overwrite an existing variable by using the *-force* parameter of *New-Variable*. Of course, this is only possible if the existing variable wasn't created with the *Constant* option. Variables of the constant type are unchangeable once they have been created, and -force does not change this:

```
# Parameter -force overwrites existing variables if these do not
# use the "Constant" option:
New-Variable test -value 100 -description "test variable" -force

  New-Variable : variable "test" may not be removed since it is a
  constant or write-protected.
  At line:1 char:13
  + New-Variable  <<<< test -value 100 -description "test variable"

# normal variables may be overwritten with -force without difficulty.
$available = 123
New-Variable available -value 100 -description "test variable" -force
```

Variables with Description

Variables can have an optional description that helps you keep track of what the variable was intended for. However, this description appears to be invisible:

```
# Create variable with description:
New-Variable myvariable -value 100 -description "test variable" -force
# Variable returns only the value:
$myvariable

  100

# Dir and Get-Variable also do not deliver the description:
Dir variable:\myvariable

  Name                           Value
  ----                           -----
  myvariable                     100

Get-Variable myvariable

  Name                           Value
  ----                           -----
  myvariable                     100
```

By default, PowerShell only shows the most important properties of an object, and the description of a variable isn't one of them. If you'd like to see the description, you have to explicitly request it. You can do this by using the cmdlet *Format-Table* (you'll learn much about this in Chapter 5). Using *Format-Table,* you can specify the properties of the object that you want to see:

```
# variable contains a description:
dir variable:\myvariable |
  Format-Table Name, Value, Description -autosize

  Name Value Description
  ---- ----- -----------
  test   100 test variable
```

"Automatic" PowerShell Variables

PowerShell uses variables, too, for internal purposes and calls those "automatic variables." These variables are available right after you start PowerShell since PowerShell has defined them during launch. The drive *variable:* provides you with an overview of all variables:

```
Dir variable:

  Name                           Value
  ----                           -----
  Error                          {}
  DebugPreference                SilentlyContinue
  PROFILE                        C:\Users\Tobias Weltner\Documents\
                                 WindowsPowerShell\Micro...
  HOME                           C:\Users\Tobias Weltner
  (...)
```

To understand the meaning of automatic variables, you can simply view their description:

```
Dir variable: | Sort-Object Name |
  Format-Table Name, Description -autosize -wrap

  Name                   Description
  ----                   -----------
  $
  ?                      Execution status of last command.
  ^
  _
  ConfirmPreference      Dictates when confirmation should be requested.
                         Confirmation is requested when the ConfirmImpact
                         of the operation is equal to or greater than
                         $ConfirmPreference. If $ConfirmPreference is
                         None, actions will only be confirmed when
                         Confirm is specified.
  ConsoleFileName        Name of the current console file.
  DebugPreference        Dictates action taken when an Debug message is
                         delivered.
  Error
  ErrorAction            Dictates action taken when an Error message is
   Preference            delivered.
  ErrorView              Dictates the view mode to use when displaying
                         errors.
  ExecutionContext       The execution objects available to cmdlets.
  false                  Boolean False
  FormatEnumeration      Dictates the limit of enumeration on formatting
   Limit                 IEnumerable objects.
  HOME                   Folder containing the current user's profile.
  Host                   This is a reference to the host of this
                         Runspace.
  MaximumAliasCount      The maximum number of aliases allowed in a
                         session.
```

MaximumDriveCount	*The maximum number of drives allowed in a session.*
MaximumErrorCount	*The maximum number of errors to retain in a session.*
MaximumFunctionCount	*The maximum number of functions allowed in a session.*
MaximumHistoryCount	*The maximum number of history objects to retain in a session.*
MaximumVariableCount	*The maximum number of variables allowed in a session.*
MyInvocation	
NestedPromptLevel	*Dictates what type of prompt should be displayed for the current nesting level.*
null	*References to the null variable always return the null value. Assignments have no effect.*
OutputEncoding	*The text encoding used when piping text to a native executable.*
PID	*Current process ID.*
PROFILE	
ProgressPreference	*Dictates action taken when Progress Records are delivered.*
PSHOME	*Parent folder of the host application of this Runspace.*
PWD	
ReportErrorShow ExceptionClass	*Causes errors to be displayed with a description of the error class.*
ReportErrorShow InnerException	*Causes errors to be displayed with the inner exceptions.*
ReportErrorShow Source	*Causes errors to be displayed with the source of the error.*
ReportErrorShow StackTrace	*Causes errors to be displayed with a stack trace.*
ShellId	*The ShellID identifies the current shell. This is used by #Requires.*
StackTrace	
true	*Boolean True*
VerbosePreference	*Dictates the action taken when a Verbose message is delivered.*
WarningPreference	*Dictates the action taken when a Warning message is delivered.*
WhatIfPreference	*If true, WhatIf is considered to be enabled for all commands.*

Most automatic variables are very well documented. Variables are assigned to three categories:

- **User information:** PowerShell permanently stores some important information. For example, the path name of the standard profile in *$HOME*. In addition, some standard variables, like *$true* and *$false*, are set.
- **Fine adjustments:** Numerous default settings allow the behavior of PowerShell to be modified and customized. For example, you can set how detailed error messages are reported, or whether a command should continue to execute, in the event of an error. You'll learn more about this in Chapter 11.

- **Running time information:** PowerShell returns valuable information when it executes statements. For example, a function can determine who calls it, or a script can determine the location of its folder.

In other respects, automatic variables are no different from the variables you define yourself as you can read the contents and use them in much the same way:

```
# Verify user profile:
$HOME

  C:\Users\UserA

# Verify PowerShell Process -id and access profile:
"current process -ID of PowerShell is $PID"

  current process -ID of PowerShell is 6116

Get-Process -id $PID

  Handles  NPM(K)    PM(K)      WS(K) VM(M)   CPU(s)     Id ProcessName
  -------  ------    -----      ----- -----   ------     -- -----------
      656      22   107620      72344   334   118,69   6116 PowerShell

# Open the standard user profile in notepad for editing:
notepad $profile
```

To find out more, use *Get-Help*:

```
Get-Help about_Automatic_variables
```

PowerShell write protects several of its automatic variables. While you can read them, you can't modify them. That makes sense because information, like the process-ID of the PowerShell console or the root directory, should not be modified.

```
$pid = 12

  Cannot overwrite variable "PID" because it is read-only or
  constant.
  At line:1 char:5
  + $pid  <<<< = 12
```

A little later in this chapter, you'll find out more about how write-protection works. You'll then be able to turn write-protection off and on for variables that already exist. However, you should never do this for automatic variables because that can cause the PowerShell console to crash. One reason is because PowerShell continually modifies some variables. If you set them to read-only, PowerShell may stop and not respond to any inputs.

Environment Variables

Older consoles do not typically have a variable system of their own that was as sophisticated as PowerShell's. Instead, those consoles relied on "environment variables," which are managed by Windows itself. Environment variables are important sources of information for PowerShell because they include many details about the operating system. Moreover, while PowerShell's variable are visible only inside of the current PowerShell session, environment variables can persist and thus can be readable by other programs.

Working with environment variables in PowerShell is just as easy as working with internal PowerShell variables. All you have to do is to tell PowerShell precisely which variable you mean. To do this, you should specify the variable source at the beginning of the variable name. For environment variables, it's *env:*.

Reading Particular Environment Variables

You can read the location of the Windows folder of the current computer from a Windows environment variable:

```
$env:windir

  C:\Windows
```

By adding *env:*, you've instructed PowerShell not to look for the variable *windir* in the normal PowerShell variable store, but in Windows environment variables. In other respects, the variable behaves just like any other PowerShell variable. For example, you could embed it in the text:

```
"The Windows folder is here: $env:windir"
The Windows folder is here: C:\Windows
```

You can just as easily use the variable with commands and switch over temporarily to the Windows folder in the following way:

```
# save in current folder:
Push-Location
# change to Windows folder
cd $env:windir
Dir
# change back to initial location after executed task
Pop-Location
```

Searching for Environment Variables

PowerShell keeps track of Windows environment variables and lists them in the *env:* virtual drive. So, if you'd like an overview of all existing environment variables, you should just list the contents of the *env:* drive:

```
Dir env:
    Name                Value
    ----                -----
    Path                C:\Windows\system32;C:\Windows;C:\Windows\System32
                        \Wbem;C:\
    TEMP                C:\Users\TOBIAS~1\AppData\Local\Temp
    ProgramData         C:\ProgramData
    PATHEXT             .COM;.EXE;.BAT;.CMD;.VBS;.VBE;.JS;.JSE;.WSF;.WSH;
                        .MSC;.4mm
    ALLUSERSPROFILE     C:\ProgramData
    PUBLIC              C:\Users\Public
    OS                  Windows_NT
    USERPROFILE         C:\Users\Tobias Weltner
    HOMEDRIVE           C:
    (...)
```

You'll be able to retrieve the information it contains when you've located the appropriate environment variable and you know its name:

```
  $env:userprofile

    C:\Users\Tobias Weltner
```

Creating New Environment Variables

You can create completely new environment variables in the same way you create normal variables. Just specify in which area the variable is to be created, with *env:*

```
  $env:TestVar = 12
  Dir env:\t*

    Name                              Value
    ----                              -----
    TMP                               C:\Users\TOBIAS~1\AppData\Local\Temp
    TEMP                              C:\Users\TOBIAS~1\AppData\Local\Temp
    TestVar                           12
```

Deleting and Modifying Environment Variables

Deleting and modifying environment variables are done in the same way as normal PowerShell variables. For example, if you'd like to remove the environment variable *windir*, just delete it from the *env:*drive:

```
  # Environment variable will be deleted:
  del env:\windir
  # Deleted environment variables are no longer available:
  $env:windir
```

You can modify environment variables by simply assigning new variables to them. The next line will turn your system into an Apple computer—at least to all appearances:

```
$env:OS = "Apple MacIntosh OS X"
Dir env:

  Name                             Value
  ----                             -----
  Path                             C:\Windows\system32;C:\Windows;
                                   C:\Windows\System32\Wbem;C:\
  (...)
  OS                               Apple MacIntosh OS X
  USERPROFILE                      C:\Users\Tobias Weltner
  HOMEDRIVE                        C:
```

Aren't these changes dangerous? After all, the environment variables control the entire system. Fortunately, all changes you make are completely safe and reversible. PowerShell works with a copy of real environment variables, the so called "process" set. After closing and restarting PowerShell, the environment variables will return to their previous state. Your changes only affect the current PowerShell session. Use direct .NET framework methods to change environment variables persistently. We cover those in a moment.

You can add new folders to the list of trustworthy folders by changing or appending environment variables. You have read in Chapter 2 that content in trustworthy folders (documents, scripts, programs) can be launched in PowerShell without having to specify an absolute or relative path name or even a file extension.

```
# Create a special folder:
md c:\myTools
# Create an example script in this folder:
" 'Hello!' " > c:\myTools\sayHello.ps1
# Usually, you would have to specify a qualified path name:
C:\myTools\sayHello.ps1

  Hello!

# The folder is now added to the path environment:
$env:path += ";C:\myTools"
# All scripts and commands can be started immediately in this
# folder simply by entering their name:
sayHello

  Hello!
```

Permanent Modifications of Environment Variables

All changes to environment variables only affect the local copy that your PowerShell session is using. To make changes permanent, you have two choices. You can either make the changes in one of your profile scripts, which get executed each time you launch PowerShell or you can use sophisticated .NET methods directly to change the underlying original environment variables. When you do this your changes are permanent.

```
$oldValue = [environment]::GetEnvironmentvariable("Path", "User")
```

```
$newValue = ";c:\myTools"
[environment]::SetEnvironmentvariable("Path", $newValue, "User")
```

note

Access to commands of the .NET Framework as shown in this example will be described in depth in Chapter 6.

When you close and restart PowerShell, the *Path* environment variable will now retain the changed value. You can easily check this:

```
$env:Path
```

The permanent change you just made applies only to you, the logged-on user. If you'd like the change to be in effect for all computer users, replace the *"User"* argument by *"Machine."* You will need full administrator privileges to do that.

important

Change environment variables permanently only when there is no other way. For most purposes, it is completely sufficient to change the temporary process set from within PowerShell.

Drive Variables

When you access variables outside of PowerShell's own variable system (like the environment variables), the prefix to the variable name really is just the name of the virtual drive that gives access to the information. Let's take a closer look:

```
$env:windir
```

Using this statement, you've just read the contents of the environment variable *windir*. However, in reality, *env:windir* is a file path and leads to the "file" *windir* on the *env:*drive. So, if you specify a path name behind "$", this variable will furnish the contents of the specified "file".

Directly Accessing File Paths

This actually works with (nearly) all drives, even with real data drives. In this case, the direct variable returns the contents of the actual file. The path must be enclosed in braces because normal files paths include special characters like ":" and "\", which PowerShell can misinterpret:

```
${c:\autoexec.bat}

  REM Dummy file for NTVDM
```

And there's yet another restriction: the path behind "$" is always interpreted literally. You cannot use variables or environment variables in it. As a result, the following command would be useless because PowerShell wouldn't find the file:

```
${$env:windir\windowsupdate.log}
```

tip This problem could be solved by the cmdlet *Invoke-Expression*. It executes any kind of command that you pass as a string. Here, you could assemble the path name and pass it to *Invoke-Expression*:

```
$command = "`${$env:windir\windowsupdate.log}"
Invoke-Expression $command
```

The "`" character in front of the first "$", by the way, is not a typo but a character as it's known as the "backtick" character. You specify it in front of all characters that normally have a special meaning that you want to override during the current operation. Without the backtick character, PowerShell would interpret the contents in the first line as a direct variable and replace it with the value of the variable. But after a backtick, the "$" character remains a normal text character.

Why didn't we enclose the text in the first line in simple quotation marks? Because then PowerShell wouldn't have made any automatic replacements. The environment variable *$env:windir* wouldn't have been resolved, either. Consequently, you need the backtick character in text whenever you want to resolve only part of the text.

Direct variables work with most (but not all) drives that *Get-PSDrive* reports. For example, you would address the function with your path name to see the definition of a function:

```
$function:tabexpansion
```

You can also load functions in Notepad in this way:

```
$function:tabexpansion > function.ps1; notepad function.ps1
```

Area allocator	**Description**
env:	Environment variables
function:	Functions
variable:	Variables

[Path name]	File system

Table 3.2: Variable areas made available by external providers

Ad-hoc Variables: Sub-Expressions

There are also variables that are never assigned a value in the first place. Instead, the variable contains an expression. The expression is evaluated and yields the result each time you query the variable. The code in the parentheses always recalculates the content of this "variable."

```
$(2+2)

  4
```

Why not just simply write:

```
(2+2)

  4
```

Or even simpler:

```
2+2

  4
```

$(2+2) is a variable and, consequently, like all other variables, can be embedded. For example, in text:

```
"Result = $(2+2)"

  Result = 4
```

You'll find that ad hoc variables are important once you're working with objects and want to output a particular object property. We'll discuss objects in more detail later in Chapter 6. Until then, the following example should make the principle clear:

```
# Get file:
$file = Dir c:\autoexec.bat
# File size given by length property:
$file.length
# To embed the file size in text, ad hoc variables are required:
"The size of the file is $($file.Length) bytes."
```

Try this without ad hoc variables. PowerShell would only have replaced *$file* with the value of the variable and appended ".Length" as static text:

```
"The size of the file is $($file.Length) bytes."
The size of the file is

  C:\autoexec.bat.Length bytes.
```

Scope of Variables

PowerShell variables can have a "scope" which determines where a variable is available. PowerShell supports four special variable scopes: *global*, *local, private*, and *script*. These scopes allow you to restrict variable visibility in functions or scripts.

Automatic Restriction

If you don't do anything at all, PowerShell will automatically restrict the visibility of its variables. To see how this works, create a little test script:

```
Notepad test1.ps1
```

Notepad will open. Type the following script, save it, and then close Notepad:

```
$windows = $env:windir
"Windows Folder: $windows"
```

Now call your script:

```
.\test.ps1
```

important

If your script doesn't start, script execution may be turned off. By entering the command *Set-ExecutionPolicy RemoteSigned*, you can grant PowerShell permission to run scripts. You'll learn more about this in Chapter 10.

The script reports the Windows folder. From within the script, the folder path is stored in the variable *$windows*. After the script has done its work, take a look to see what variables the script has left behind: retrieve the variable *$windows*. It's empty. The variables in your script were defined in a different scope than the variables within your console and so were isolated from each other. *$windows* in the console and *$windows* in your script are, in fact, completely different variables as shown by this script:

```
$windows = "Hello"
.\test1.ps1
$windows
"Hello"
```

Although the script in its variable *$windows* stored other information, the variable *$windows* in your console retains its value. PowerShell normally creates its own variable scope for every script and every function.

Changing Variable Visibility

You can easily find out how the result would have looked without automatic restrictions on variable visibility. All you do is type a single dot "." before the script file path to turn off restrictions on visibility. Type a dot and a space in front of the script:

```
$windows = "Hello"
. .\test1.ps1
$windows
"C:\Windows"
```

This time, the variables within the script will take effect on variables in the console. If you launch the script "dot-sourced," PowerShell won't create new variables for your script. Instead, it uses the variable scope of the caller. That has advantages and disadvantages that you'll have to weigh carefully in each application.

Advantage of Lifting Visibility Restrictions: Clear and Unambiguous Start Conditions

Imagine an example in which a script creates a read-only variable as a constant. Such variables may neither be modified nor removed. This won't be a problem if you start the script with scoping restrictions because the constant is created in the variable scope of the script. The entire variable scope will be completely disposed of when the script ends. Constants that you create in scripts are therefore write-protected only within the script. You can create another test script to verify that:

```
Notepad test2.ps1
```

Type in it the following code, which creates a read-only constant:

```
New-Variable a -value 1 -option Constant
"Value: $a"
```

Save the test script and close Notepad. The write-protected constant will be created when you start the script the way you would normally, , but it will also be removed when the script ends. You can run the script as often as you wish:

```
.\test2.ps1

  Value: 1

.\test2.ps1

  Value: 1
```

Now try to call the "dot-sourced" script. Because it doesn't include any scoping restrictions anymore, the constant will not be created in the variable scope of the script, but in the variable scope of the caller, i.e., the console. The constant will be preserved when the script ends. If you call the script a second time, it will fail because it can't overwrite the constant that still exists from the script that was last invoked:

```
. .\test2.ps1

  Value: 1

. .\test2.ps1

  New-Variable : A variable with the name "a" already exists.
  At C:\Users\Tobias Weltner\test2.ps1:1 char:13
  + New-Variable  <<<< a -value 1 -option Constant
```

It's interesting that you can still always run the script, despite the existing variable *$a,* if you start it again normally and with its own variable scope:

```
.\test2.ps1

  Value: 1
```

The script now takes all variables from the caller's variable scope, and so the existing variable *$a* as well, but when new variables are created or existing ones modified, this happens exclusively in the script's own variable scope. Therefore, conflicts are minimized when scoping restriction is active.

note

This works conversely, too: use the *AllScope* option if you'd like to expressly prevent the own variable scope from redefining a variable from another variable scope. This way, the variable will be copied automatically to every new variable scope and created there as a local variable. This enables you to prevent constants from being re-defined in another variable scope:

```
# Test function with its own local variable scope tries to
# redefine the variable $setValue:
Function Test {$setValue = 99; $setValue }
# Read-only variable is created. Test function may modify this
# value nevertheless by creating a new local variable:
New-Variable setValue -option "ReadOnly" -value 200
Test

  99

# Variable is created with the AllScope option and automatically
# copied to local variable scope. Overwriting is now no longer
# possible.
Remove-Variable setValue -force
New-Variable setValue -option "ReadOnly,<b>AllScope</b>" -value
```

```
200

  The variable "setValue" cannot be overwritten since it is a
  constant or read-only.
  At line:1 char:27
  + Function Test {$setValue  <<<< = 99; $setValue }
  200
```

Setting the Scope of Individual Variables

Up to now, the governing principle was "all or nothing": either all variables of a function or a script were private or they were public (global). Now, let's use the scope modifiers *private*, *local*, *script*, and *global*.

Scope allocation	Description
$private:test = 1	The variable will be created only in the current scope and not passed to other scopes. Consequently, it can only be read and written in the current scope.
$local:test = 1	Variables will be created only in the local scope. That is the default for variables that are specified without a scope. Local variables can be read from scopes originating from the current scope, but they cannot be modified.
$script:test = 1	The variable is valid only in a script, but valid everywhere in it. Consequently, a function in a script can address other variables, which, while defined in a script, are outside the function.
$global:test = 1	The variable is valid everywhere, even outside functions and scripts.

Table 3.3: Variable scopes and validity of variables

PowerShell automatically creates scopes, even when you first start the PowerShell console. It gets the first (global) scope. Additional scopes will be added when you use functions and scripts. Every function and every script acquires its own scope. As long as you work from within the PowerShell console, there will be only one scope. In this case, all scope allocations will function in exactly the same way:

```
$test = 1
$local:test

  1

$script:test = 12
$global:test

  12

$private:test

  12
```

Create a second scope by defining a function. As soon as you call the function, PowerShell will switch to the function's own new scope. And now things appear somewhat confusing: which rules apply to variables and their validity? Let's take a look at what happens to variables that you create in the scope of the console and then read or modify in the scope of the function:

```
# Define test function:
Function test { "variable = $a"; $a = 1000 }
# Create variable in console scope and call test function:
$a = 12
Test

  variable = 12

# After calling test function, control modifications in console scope:
$a

  12
```

When you don't use any special scope allocators, a new scope can read the variables of the old scope, but not change them. If the new scope modifies a variable from the old scope, as in the example above, then the modification will be automatically created in a new local variable of the new scope. The modification has no effect on the old scope.

Is it possible to prevent variables from the old scope from being read by a new scope? The answer is yes. Variables are *private* for the allocator, since the variables that you create with it are not passed to other scopes. The function then reports "variable = ", because the variable *$a* is suddenly invisible to the function.

```
# Define test function:
Function test { "variable = $a"; $a = 1000 }
# Create variable in console scope and call test function:
$private:a = 12
Test

  variable =

# Check variable for modifications after calling test function in console scope:
```

```
$a

  12
```

important

Only when you create a completely new variable by using *$private:* is it in fact private. If the variable already existed, PowerShell will not reset the scope of the existing variable. That is (somewhat) logical, because there is only one scope in the console scope. The existing variable is found under the *private:* allocator and so is not created again.

To achieve the result you expect, you must either first remove the existing variable $a using the statement *Remove-Variable a* before you create it again, or manually allocate the status of a private variable to an existing variable: *(Get-Variable a).Options = "Private"*. Also, by using *(Get-Variable a).Options = "None"* you can make a variable become a local variable again. The scope of a variable is disclosed, as shown in Table 3.6, by selecting the *Options* property.

It works conversely too as the function can also modify the variable in the console scope. That's the purpose of the *global:* allocator. If it's specified, then the statement changes the variable in all existing scopes:

```
# Define test function:
Function test { "variable = $a"; $global:a = 1000 }
# Create variable in console scope and call test function:
Remove-Variable a
$private:a = 12
Test

  variable =

# After calling test function check variable for modifications
# in console:
$a

  1000
```

The allocator *script:* works in a very similar way. It makes a variable global inside of a script, but does not touch variables outside of the script. If you call the function directly from within the console, then *global:* and *script:* will supply the same result. But when you use *script:* from within PowerShell scripts, you will create variables that are valid everywhere within the script. However, after termination of the script, will have no effect on the console used to call the script.

Scope	**Use**
$global	The variable is valid in all scopes and is preserved when a script or a

	function ends its work.
$script	The variable is valid only within a script, but everywhere within it. Once the script is executed, the variable is removed.
$private	The variable is valid only in the current scope, either a script or a function. It cannot be passed to other scopes.
$local	The variable is valid only in the current scope. All scopes called with it can read, but not change, the contents of the variable. Modifications are also stored in new local variables of the current scope. *$local:* is the default if you don't specify a particular scope.

Table 3.4: Practical usage of scope allocations

Variable Types and "Strongly Typing"

Variables store arbitrary information when PowerShell automatically picks the appropriate data type. You don't have to do anything. However, by appending the command *.GetType().Name* to a variable, you can verify the data type that PowerShell has chosen for a variable. You don't even need the variable. Type the value in parentheses and call *.GetType().Name* to find out in which data type PowerShell stores the value:

```
(12).GetType().Name

  Int32

(1000000000000).GetType().Name

  Int64

(12.5).GetType().Name

  Double

(12d).GetType().Name

  Decimal

("H").GetType().Name

  String

(Get-Date).GetType().Name
```

```
    DateTime
```

PowerShell assigns the best-fit *primitive* data type for a given value. If a number is too large for a 32-bit integer, it will use a 64-bit integer. If it's a decimal number, then the *Double* data type will be used. In the case of text, PowerShell uses the *String* data type. Date and time values are stored in *DateTime* objects.

This process of automatic selection is called "weakly typed," and while easy, it's also often restrictive—or even risky. If PowerShell picks the wrong data type, strange things can happen. For example, let's say a variable should really store the number of files to be copied. If you erroneously assign a text value instead of a numeric value to this variable, PowerShell will happily store the text, not the number. The variable type will be automatically modified. This is why professional programmers and script developers often prefer strongly typed variables that specify the exact type of data to be stored, rather than delivering error messages when a wrong data type is assigned.

Another reason for a strong type specification: Every data type has its own set of helper functions. In fact, PowerShell doesn't always select the best data type for a particular value. For example, date, time and XML, are by default stored as plain text in a *String* data type. This is somewhat unfortunate, because you'll have to do without many useful date or XML commands that use specialized *DateTime* or *XML* data types. So, in practice, there are two important reasons for you to set the variable type yourself:

- **Type safety:** If you have assigned a type to a variable yourself, then the type will be preserved no matter what happens and will never be automatically modified. You can be *absolutely* sure that a value of the correct type is stored in the variable. If later on someone were to mistakenly assign a value to the variable that doesn't match the originally chosen type, this will cause an error message to be delivered.
- **Special variable types:** When automatically assigning a variable type, PowerShell takes into consideration only general variable types like *Int32* or *String*. Often, it's appropriate to store values in a specialized variable type like *DateTime* in order to be able to use the special commands and options available for this variable type.

Assigning Fixed Types

To assign a particular type to a variable, enclose it in square brackets before the variable name. For example, if you know that a particular variable should hold only numbers in the range 0 to 255, you could create this variable explicitly with the *Byte* type:

```
[Byte]$flag = 12
$flag.GetType().Name

  Byte
```

The variable will now store your contents in a single byte, which is not only very economical, but it will also flag it with an error if a value outside the permissible range is specified:

```
$flag = 300

  The value "300" cannot be converted to the type "System.Byte".
  Error: "The value for an unsigned byte was too large or too small."
  At line:1 char:6
```

```
    + $flag  <<<< = 300
```

The Advantages of Specialized Types

There is an additional and important reason to assign data types manually because every data type has its own set of special commands. For example, a date can be stored as text in a *String* data type. And that's just exactly what PowerShell does: it's not clever enough to automatically guess that this really is a date or time:

```
$date = "November 12, 2004"
$date

  November 12, 2004
```

If you store a date as *String*, then you'll have no access to special date functions. Only *DateTime* objects make them available. So, if you're working with date and time indicators, it's better to store them explicitly as *DateTime*:

```
[datetime]$date = "November 12, 2004"
$date

  Friday, November 12, 2004 00:00:00
```

The output of the variable will now immediately tell you the day of the week corresponding to the date, and also enable comprehensive date and time calculation commands. That makes it easy, for example, to find the date 60 days later:

```
$date.AddDays(60)

  Tuesday, January 11, 2005 00:00:00
```

PowerShell supports all the usual .NET variable types that you find in Table 3.5. XML documents can be much better processed using the *XML* data type then the standard *String* data type:

```
# PowerShell stores a text in XML format as a string:
$t = "<servers><server name='PC1' ip='10.10.10.10'/>" +
     "<server name='PC2' ip='10.10.10.12'/></servers>"
$t

  <servers><server name='PC1' ip='10.10.10.10'/>
  <server name='PC2' ip='10.10.10.12'/></servers>

# If you assign the text to a data type[xml], you'll
# suddenly be able to access the XML structure:
[xml]$list = $t
$list.servers

  server
  ------
  {PC1, PC2}
```

```
$list.servers.server

  name                                              ip
  ----                                              --
  PC1                                               10.10.10.10
  PC2                                               10.10.10.12

# Even changes to the XML contents are possible:
$list.servers.server[0].ip = "10.10.10.11"
$list.servers

  name                                              ip
  ----                                              --
  PC1                                               10.10.10.11
  PC2                                               10.10.10.12

# The result could be output again as text, including the
# modification:
$list.get_InnerXML()

  <servers><server name="PC1" ip="10.10.10.11" />
  <server name="PC2" ip="10.10.10.12" /></servers>
```

Variable type	**Description**	**Example**
[array]	An array	
[bool]	Yes-no value	[boolean]$flag = $true
[byte]	Unsigned 8-bit integer, 0...255	[byte]$value = 12
[char]	Individual unicode character	[char]$a = "t"
[datetime]	Date and time indications	[datetime]$date = "12.Nov 2004 12:30"
[decimal]	Decimal number	[decimal]$a = 12 $a = 12d
[double]	Double-precision floating point decimal	$amount = 12.45
[guid]	Globally unambiguous 32-byte	[guid]$id =

	identification number	[System.Guid]::NewGuid( ) $id.toString()
[hashtable]	Hash table	
[int16]	16-bit integer with characters	[int16]$value = 1000
[int32], [int]	32-bit integers with characters	[int32]$value = 5000
[int64], [long]	64-bit integers with characters	[int64]$value = 4GB
[nullable]	Widens another data type to include the ability to contain null values. It can be used, among others, to implement optional parameters	[Nullable``1[[System.DateTime]]]$test = Get-Date $test = $null
[psobject]	PowerShell object	
[regex]	Regular expression	$text = "Hello World" [regex]::split($text, "lo")
[sbyte]	8-bit integers with characters	[sbyte]$value = -12
[scriptblock]	PowerShell scriptblock	
[single], [float]	Single-precision floating point number	[single]$amount = 44.67
[string]	String	[string]$text = "Hello"
[switch]	PowerShell switch parameter	
[timespan]	Time interval	[timespan]$t = New-TimeSpan $(Get-Date) "1.Sep 07"
[type]	Type	

[uint16]	Unsigned 16-bit integer	[uint16]$value = 1000
[uint32]	Unsigned 32-bit integer	[uint32]$value = 5000
[uint64]	Unsigned 64-bit integer	[uint64]$value = 4GB
[xml]	XML document	

Table 3.5: Variable types

Variable Management: Behind the Scenes

Whenever you create a new variable in PowerShell, it will be stored "behind the scenes" in a *PSVariable* object. This object contains not just the value of the variable, but also other information, such as the description that you assigned to the variable or additional options like write-protection.

If you retrieve a variable in PowerShell, PowerShell will return only the variable value. If you'd like to see the remaining information that was assigned to the variable, you'll need the underlying *PSVariable* object. *Get-Variable* will get it to you:

```
$testvariable = "Hello"
$psvariable = Get-Variable testvariable
```

You can now display all the information about *$testvariable* by outputting *$psvariable*. To see all object properties and not just the default properties, pipe the output to the cmdlet *Format-List*:

```
$psvariable | Format-List

  Name        : testvariable
  Description :
  Value       : Hello
  Options     : None
  Attributes  : {}
```

- **Description:** The description you specified for the variable.
- **Value:** the value assigned currently to the variable (i.e. its contents).
- **Options:** Options that have been set such as write-protection or *AllScope*.
- **Attributes:** Additional features, such as permitted data type of a variable for strongly typed variables. The brackets behind *Attributes* indicate that this is an array, which can consist of several values that can be combined with each other.

Subsequent Modification of Variables Options

One reason for dealing with the *PSVariable* object of a variable is to modify the variable's settings. Use either the cmdlet *Set-Variable* or directly modify the *PSVariable* object. For example, if you'd like to change the description of a variable, get the appropriate *PSVariable* object and modify its *Description* property:

```
# Create new variable:
$test = "New variable"
# Create PSVariable object:
$psvariable = Get-Variable test
# Modify description:
$psvariable.Description = "Subsequently added description"
Dir variable:\test | Format-Table name, description

  Name                Description
  ----                -----------
  test                Subsequently added description

# Get PSVariable object and directly modify the description:
(Get-Variable test).Description =
  "An additional modification of the description."
Dir variable:\test | Format-Table name, description

  Name                Description
  ----                -----------
  test                An additional modification of the description.

# Modify a description of an existing variable with Set-Variable:
Set-Variable test -description "Another modification"
Dir variable:\test | Format-Table name, description

  Name                Description
  ----                -----------
  test                Another modification
```

As you can see in the example above, you do not need to store the *PSVariable* object in its own variable to access its *Description* property. Instead, use a sub-expression, i.e. a statement in parentheses. PowerShell will then evaluate the contents of the sub-expression separately. The expression directly returns the required *PSVariable* object so you can then call the *Description* property directly from the result of the sub-expression. You could have done the same thing by using *Set-Variable*. Reading the settings works only with the *PSVariable* object:

```
(Get-Variable test).Description

  An additional modification of the description.
```

Activating Write-Protection

You can manipulate other variable properties, too. For example, if you'd like to write-protect a variable, do this:

```
$Example = 10
# Put option directly in PSVariable object:
(Get-Variable Example).Options = "ReadOnly"
# Modify option as wish with Set-Variable; because the variable
# is read-only, -force is required:
Set-Variable Example -option "None" -force
# Write-protection turned off again; variable contents may now
# be modified freely:
$Example = 20
```

The *Constant* option must be set when a variable is created because you may not convert an existing variable into a constant.

```
# A normal variable may not be converted into a constant:
$constant = 12345
(Get-Variable constant).Options = "Constant"

  Exception in setting "Options": "The existing variable "constant"
  may not be set as a constant. Variables may only be set as
  constants when they are created."
  At line:1 char:26
  + (Get-Variable constant).O <<<< options = "Constant"
```

The remaining two options, *Private* and *AllScope*, are the basis for local and global variables as they can then be extracted using the method described above.

Option	**Description**
"None"	NO option (default)
"ReadOnly"	Variable contents may only be modified by means of the *-force* parameter
"Constant"	Variable contents can't be modified at all. This option must already be specified when the variable is created. Once specified this option cannot be changed.
"Private"	The variable is visible only in a particular context (local variable).
"AllScope"	The variable is automatically copied in a new variable scope.

Table 3.6: Options of a PowerShell variable

Type Specification of Variables

PowerShell stores the strict data type of a variable in the *Attributes* property if you specified a special type. As long as *Attributes* is empty, the variable will store any type of data and PowerShell will automatically select the appropriate data type.

Once you assign a fixed data type to a variable, the data type will be stored in the *Attributes* property, setting the variable to the assigned data type. If you delete the *Attributes* property, the variable will be un-typed again and stores all kinds of data:

```
# List attributes and delete:
(Get-Variable a).Attributes

  TypeId
  ------
  System.Management.Automation.ArgumentTypeConverterAttribute

# Delete type specification:
(Get-Variable a).Attributes.Clear()
# Strong type specification is removed; now the variable can
# store text again:
$a = "Test"
```

Verifying and Validating Variable Contents

The *Attributes* property of a *PSVariable* object can include additional conditions, such as the maximum length of a variable. In the following example, a valid length from 2 to 8 characters is assigned to a variable. An error will be generated if you try to store text that is shorter than 2 characters or longer than 8 characters:

```
$a = "Hello"
$aa = Get-Variable a
$aa.Attributes.Add($(New-Object `
  System.Management.Automation.ValidateLengthAttribute `
  -argumentList 2,8))
$a = "Permitted"
$a = "Prohibited because its length is not from 2 to 8 characters"

  Because of an invalid value verification (Prohibited because
  its length is not from 2 to 8 characters) may not be carried out for
  the variable "a".
  At line:1 char:3
  + $a  <<<< = "Prohibited because its length is not from 2 to 8
```

In the above example *Add()* added a new .NET object to the *attributes* with *New-Object*. You'll learn more about *New-Object* in Chapter 6. Along with *ValidateLengthAttribute*, there are additional restrictions that you can place on variables.

Restriction	**Category**
Variable may not be zero	*ValidateNotNullAttribute*
Variable may not be zero or empty	*ValidateNotNullOrEmptyAttribute*
Variable must match a Regular Expression	*ValidatePatternAttribute*
Variable must match a particular number range	*ValidateRangeAttribute*
Variable may have only a particular set value	*ValidateSetAttribute*

Table 3.7: Available variable validation classes

In the following example, the variable must contain a valid e-mail address or all values not matching an e-mail address will generate an error. The e-mail address is defined by what is called a Regular Expression. You'll learn more about Regular Expressions in Chapter 13.

```
$email = "tobias.weltner@powershell.com"
$v = Get-Variable email
$pattern = "\b[A-Z0-9._%+-]+@[A-Z0-9.-]+\.[A-Z]{2,4}\b"
$v.Attributes.Add($(New-Object `
  System.Management.Automation.ValidatePatternAttribute `
  -argumentList $pattern))
$email = "valid@email.de"
$email = "invalid@email"

  Because of an invalid value verification (invalid@email) may not
  be carried out for the variable "email".
  At line:1 char:7
  + $email  <<<< = "invalid@email"
```

If you want to assign a set number range to a variable, use *ValidateRangeAttribute*. The variable *$age* accepts only numbers from 5 to 100:

```
$age = 18
$v = Get-Variable age
$v.Attributes.Add($(New-Object `
  System.Management.Automation.ValidateRangeAttribute `
  -argumentList 5,100))
$age = 30
$age = 110
```

```
    Because of an invalid value verification (110) may not be
    carried out for the variable "age".
    At line:1 char:7
    + $age  <<<< = 110
```

If you would like to limit a variable to special key values, *ValidateSetAttribute* is the right option. The variable *$option* accepts only the contents *yes*, *no*, or *perhaps*:

```
  $option = "yes"
  $v = Get-Variable option
  $v.Attributes.Add($(New-Object `
    System.Management.Automation.ValidateSetAttribute `
    -argumentList "yes", "no", "perhaps"))
  $option = "no"
  $option = "perhaps"
  $option = "don't know"

    Verification cannot be performed because of an invalid value
    (don't know) for the variable "option".
    At line:1 char:8
    + $option  <<<< = "don't know"
```

pro tip

The validations that you applied to variables in the above example were originally designed for cmdlets, but you can also use them for variables as well.

If you'd like to find out more about the parameters that a cmdlet accepts, you should simply examine the attribute of the cmdlet parameter and look for validation entries. The following example examines all parameters of the *Get-ChildItem* cmdlet and takes a closer look at the range of permitted values of the *-OutBuffer* parameter:

```
# Output all parametersets:
(Get-Command Get-ChildItem).ParameterSets

  (...)

# Output names of parametersets:
(Get-Command Get-ChildItem).ParameterSets |
  ForEach-Object { $_.Name }

  Items
  LiteralItems

# List all parameters of all parametersets:
(Get-Command Get-ChildItem).ParameterSets |
  ForEach-Object { $_.Parameters } | ForEach-Object { $_.Name }
# Select one parameter:
$parameter = (Get-Command Get-ChildItem).ParameterSets |
  ForEach-Object { $_.Parameters } |
  Where-Object { $_.Name -eq "OutBuffer" } |
  Select-Object -first 1
$parameter

  Name                            : OutBuffer
  ParameterType                   : System.Int32
  IsMandatory                     : False
  IsDynamic                       : False
  Position                        : -2147483648
  ValueFromPipeline               : False
  ValueFromPipelineByPropertyName : False
  ValueFromRemainingArguments     : False
  HelpMessage                     :
  Aliases                         : {ob}
  Attributes                      :
  {System.Management.Automation.
                                    AliasAttribute,
  __AllParameter
                                    Sets,System.Management.Auto
  mat
                                    ion.ValidateRangeAttribute}

# Determine permitted values:
$parameter.Attributes |
  Where-Object { $_.TypeId -match "ValidateRangeAttribute" }

  MinRange    MaxRange   TypeId
  --------    --------   ------
  0         2147483647   System.Management.Automat...
```

Summary

Variables store any information. The variable name always begins with the dollar sign "$". The variable name can consist of numbers, characters, and special characters like the underline character "_". Variables are not case-sensitive. If you'd like to use characters in variable names with special meaning to PowerShell (like parenthesis), the variable name must be enclosed in braces. PowerShell doesn't require that variables be specifically created or declared before use.

Aside from the variables that you create yourself, there are predefined variables that PowerShell creates called "automatic variables." These variables function like self-defined variables, but they already include useful key system data or configuration data for PowerShell.

PowerShell always stores variables internally in a *PSVariable* object. For example, it contains settings that write-protect a variable or attach a description to it (Table 3.6). It's easiest for you to activate this special function by using the *New-Variable* or *Set-Variable* cmdlets (Table 3.1).

By default, variables store any values you want. PowerShell automatically ensures that the variable type matches the value. If you'd like to set variables to a particular variable type ("strong type specification"), specify the desired type (Table 3.5) in square brackets before the variable name. Then the variable will store only the values that match the type. In addition, the variable will now enable the special commands associated with the variable type, such as date manipulation and math with the *DateTime* variable type.

Every variable is created in a fixed scope, which PowerShell uses to determine the valid scope of a variable. When PowerShell starts, an initial variable scope is created, and every script and every function receive their own respective scope. You may specify a special scope by typing the name of the desired scope before the variable name and separating it with a colon from the variable name.

You can use the *local:*, *private:*, *script:*, and *global:* scopes, to address local and global variables. In addition, further providers can make their own scopes available, which enable you to address their information just like normal variables. For example, environment variables, which can be accessed through *env:* (Table 3.2).

Finally, direct variables are special variable types. Variable names determine their values. Either a valid file path is specified as a valid file path, and the variable outputs the contents of this data object, or the variable name consists of PowerShell code in parentheses. PowerShell then recalculates the respective "contents" of the variable.

CHAPTER 4.

Arrays and Hash Tables

No matter how many results a command returns, you can always store the results in a variable because of a clever trick. PowerShell automatically wraps results into an array when there is more than one result. In this chapter, you'll learn how arrays work.

You'll also discover a special type of array, a hash table. While normal arrays use a numeric index to access their elements, hash tables use key-value-pairs.

Topics Covered:

PowerShell Commands Return Arrays

If you store the result of a command in a variable and then output it, you might at first think that the variable contains plain text:

```
$a = ipconfig
$a

  Windows IP Configuration
  Ethernet adapter LAN Connection
  Media state
  . . . . . . . . . . . : Medium disconnected

  Connection-specific DNS Suffix:
     Connection location IPv6 Address  . : fe80::6093:8889:257e:8d1%8
```

```
    IPv4 address  . . . . . . . . . . . : 192.168.1.35
    Subnet Mask . . . . . . . . . . . . : 255.255.255.0
    Standard Gateway . . . . . . . . . : 192.168.1.1
```

However, that's not true. Each line is stored as a separate value in your variable and the variable is really an array. This happens automatically whenever a command returns more than one result.

Storing Results in Arrays

This is how you identify arrays:

```
$a = "Hello"
$a -is [Array]

  False

$a = ipconfig
$a -is [Array]

  True
```

If the result is an array, you can find the number of elements stored in it by using the *Count* property:

```
$a.Count

  53
```

In this example, the *ipconfig* command returned 53 single results that are all stored in *$a*. If you'd like to examine a single array element, specify its index number. If an array has 53 elements, its valid index numbers are 0 to 52 (the index always starts at 0).

```
# Show the second element:
$a[1]

  Windows IP Configuration
```

note

Whether or not the result is an array depends on the number of results that were returned. If more than one, PowerShell returns an array. Otherwise, it returns the result directly so the same command can behave differently from case to case, depending on the number of results.

```
$result = Dir
$result -is [array]

  True
```

```
$result = Dir C:\autoexec.bat
$result -is [array]

  False
```

Use the construct *@()* *if* you'd like to force a command to always return its result in an array. This way the command will always return an array, even if the command returns only one result or none at all. This way you find out the number of files in a folder:

```
$result = @(Dir)
$result.Count
```

Or in a line:

```
@(Dir).Count
```

Further Processing of Array Elements in a Pipeline

Ipconfig returns each line of text as array, enabling you to process them individually:

```
# Store result of an array and then pass along a pipeline to Select-String:
$result = ipconfig
$result | Select-String "Address"


  Connection location IPv6 Address . . . : fe80::6093:8889:257e:8d1%8
     IPv4 address  . . . . . . . . . . . : 192.168.1.35
     Connection location IPv6 Address  . : fe80::5efe:192.168.1.35%16

  Connection location IPv6 Address . . . : fe80::14ab:a532:a7b9:cd3a%11

# Everything in one line: output only lines including the
# word "address":
ipconfig | Select-String "Address"


  Connection location IPv6 Address . . . : fe80::6093:8889:257e:8d1%8
     IPv4-Adress . . . . . . . . . . . . : 192.168.1.35
  Connection location IPv6 Address . . . : fe80::5efe:192.168.1.35%16
  Connection location IPv6 Address . . . : fe80::14ab:a532:a7b9:cd3a%11
```

The result of *ipconfig* was passed to *Select-String,*which is a text filter that allows only text lines that include the searched word through the PowerShell pipeline. With minimal effort, you can reduce the results of *ipconfig* to the information you find relevant.

Working with Real Objects

Ipconfig is a legacy command, not a modern PowerShell cmdlet. While it is a command that returns individual information stored in arrays, this individual information consists of text. Real PowerShell cmdlets return rich objects, not text, even though this is not apparent at first:

```
Dir


  Directory: Microsoft.PowerShell.Core\FileSystem::C:\Users\
  Tobias Weltner
  Mode                LastWriteTime     Length Name
  ----                -------------     ------ ----
  d----        10/01/2007     16:09            Application Data
  d----        07/26/2007     11:03            Backup
  d-r--        04/13/2007     15:05            Contacts
  d----        06/28/2007     18:33            Debug
  d-r--        10/04/2007     14:21            Desktop
  d-r--        10/04/2007     21:23            Documents
  d-r--        10/09/2007     12:21            Downloads
  (...)
```

Let's check if the return value is an array:

```
$result = Dir
$result.Count

  82
```

Every element in an array represents a file or a directory. So if you output an element from the array to the console, PowerShell automatically converts the object back into text:

```
# Access the fifth element:
$result[4]


  Directory: Microsoft.PowerShell.Core\FileSystem::C:\Users\
  Tobias Weltner
  Mode                LastWriteTime     Length Name
  ----                -------------     ------ ----
  d-r--        04.10.2007     14:21            Desktop
```

You will realize that each element is much more than plain text when you pass it to the Format-List cmdlet and use an asterisk to see all of its properties:

```
# Display all properties of this element:
$result[4] | Format-List *

  PSPath            : Microsoft.PowerShell.Core\FileSystem::
                      C:\Users\Tobias Weltner\Desktop
  PSParentPath      : Microsoft.PowerShell.Core\FileSystem::
```

```
                         C:\Users\Tobias Weltner
    PSChildName        : Desktop
    PSDrive            : C
    PSProvider         : Microsoft.PowerShell.Core\FileSystem
    PSIsContainer      : True
    Mode               : d-r--
    Name               : Desktop
    Parent             : Tobias Weltner
    Exists             : True
    Root               : C:\
    FullName           : C:\Users\Tobias Weltner\Desktop
    Extension          :
    CreationTime       : 04/13/2007 01:54:53
    CreationTimeUtc    : 04/12/2007 23:54:53
    LastAccessTime     : 10/04/2007 14:21:20
    LastAccessTimeUtc  : 10/04/2007 12:21:20
    LastWriteTime      : 10/04/2007 14:21:20
    LastWriteTimeUtc   : 10/04/2007 12:21:20
    Attributes         : ReadOnly, Directory
```

You'll learn more about these types of objects in Chapter 5.

Creating New Arrays

You can create your own arrays, too. The easiest way is to use the comma operator:

```
  $array = 1,2,3,4
  $array

    1
    2
    3
    4
```

Specify the single elements that you want to store in the array and then separate them by a comma. There's even a special shortcut for sequential numbers:

```
  $array = 1..4
  $array

    1
    2
    3
    4
```

Polymorphic Arrays

Just like variables, individual elements of an array can store any type of value you assign. This way, you can store whatever you want in an array, even a mixture of different data types. You can separate the elements using commas:

```
$array = "Hello", "World", 1, 2, (Get-Date)
$array

  Hello
  World
  1
  2
  Tuesday, August 21, 2007 12:12:28
```

important Why is the *Get-Date* cmdlet in the last example enclosed in parentheses? Just try it without parentheses. Arrays can only store data. *Get-Date* is a command and no data. Since you want PowerShell to evaluate the command first and then put its result into the array, you need to use parentheses. Parentheses identify a sub-expression and tell PowerShell to evaluate and process it first.

Arrays With Only One (Or No) Element

How do you create arrays with just one single element? Here's how:

```
$array = ,1
$array.Length

  1
```

You'll need to use the construct *@(...)*to create an array without any elements at all:

```
$array = @()
$array.Length

  0

$array = @(12)
$array

  12

$array = @(1,2,3,"Hello")
$array
```

```
    1
    2
    3
    Hello
```

Addressing Array Elements

Every element in an array is addressed using its index number. Negative index numbers count from last to first. You can also use expressions that calculate the index value:

```
  # Create your own new array:
  $array = -5..12
  # Access the first element:
  $array[0]

    -5

  # Access the last element (several methods):
  $array[-1]

    12

  $array[$array.Count-1]

    12

  $array[$array.length-1]

    12

  # Access a dynamically generated array that is not stored in a variable:
  (-5..12)[2]

    -3
```

Remember, the first element in your array always has the index number 0. The index *-1* will always give you the *last* element in an array. The example demonstrates that the total number of all elements will be returned in two properties: *Count* and *Length*. Both of these properties will behave identically.

Choosing Several Elements from an Array

You can use square brackets to select multiple elements in an array. In doing that, you get a new array containing only the selected elements from the old array:

```
  # Store directory listing in a variable:
  $list = dir
  # Output only the 2nd, 5th, 8th, and 13th entry:
```

```
$list[1,4,7,12]

  Directory: Microsoft.PowerShell.Core\FileSystem::C:\Users\
  Tobias Weltner
  Mode                LastWriteTime     Length Name
  ----                -------------     ------ ----
  d----         07/26/2007     11:03     Backup
  d-r--         08/20/2007     07:52     Desktop
  d-r--         08/12/2007     10:21     Favorites
  d-r--         04/13/2007     01:55     Saved Games
```

The second line selects the second, fifth, eighth, and thirteenth elements (remember that the index begins at 0). You can use this approach to reverse the contents of an array:

```
# Create an array with values from 1 to 10
$array = 1..10
# Select the elements from 9 to 0 (output array contents
# in reverse order):
$array = $array[($array.length-1)..0]
$array

  10
  9
  ...
  1
```

pro tip

Reversing the contents of an array using the approach (described above) is not particularly efficient because PowerShell has to store the result in a new array. Instead, you should use the special array functions of the .NET Framework (see Chapter 6). They enable you to reverse the contents of an array very efficiently:

```
# Create an array containing text and output contents:
$a = ipconfig
$a
# Reverse array contents and then output it again:
[array]::Reverse($a)
$a
```

Adding Elements to an Array and Removing Them

Arrays always contain a fixed number of elements. You'll have to make a new copy of the array with a new size to add or remove elements later. You can simply use the "+=" operator to do that and then add new elements to an existing array:

```
# Add a new element to an existing array:
$array += "New Value"
```

```
$array

  1
  2
  3
  New Value
```

Array sizes can't be modified so PowerShell will work behind the scenes to create a brand-new, larger array, copying the contents of the old array into it, and adding the new element. PowerShell works exactly the same way when you want to delete elements from an array. Here, too, the original array is copied to a new, smaller array while disposing of the old array. For example, the next line removes elements 4 and 5 using the indexes 3 and 4:

```
$array = $array[0..2] + $array[5..10]
$array.Count

  9
```

Using Hash Tables

Hash tables store "key-value pairs." So, in hash tables you do not use a numeric index to address individual elements, but rather the key you assigned to a value.

Creating a New Hash Table

To create a new hash table, use *@{}* instead of *@()*, and specify the key-value pair that is to be stored in your new hash table. Use semi-colons to separate key-value pairs:

```
# Create a new hash table with key-value pairs
$list = @{Name = "PC01"; IP="10.10.10.10"; User="Tobias Weltner"}

  Name                           Value
  ----                           -----
  Name                           PC01
  IP                             10.10.10.10
  User                           Tobias Weltner

# Access to the key "IP" returns the assigned value:
$list["IP"]

  10.10.10.10

# As for arrays, several elements can be selected at the same time:
$list["Name", "IP"]

  PC01
  10.10.10.10
```

```
# A key can also be specified by dot notation:
$list.IP

  10.10.10.10

# A key can even be stored in a variable:
$key = "IP"
$list.$key

  10.10.10.10

# Keys returns all keys in the hash table:
$list.keys

  Name
  IP
  User

# If you combine this, you can output all values in the hash table
$list[$list.keys]

  PC01
  10.10.10.10
  Tobias Weltner
```

The example shows that you retrieve the values in the hash table using the assigned key. There are two forms of notation you can use to do this:

- **Square brackets:** *Either* you use square brackets, like in arrays;
- **Dot notation:** *Or* you use dot notation, like with objects, and specify respectively the key name with the value you want to return. The key name can be specified as a variable.

The square brackets can return several values at the same time exactly like arrays if you specify several keys and separate them by a comma. Note that the key names in square brackets must be enclosed in quotation marks (you don't have to do this if you use dot notation).

Storing Arrays in Hash Tables

You can store classic array inside of hash tables, too. This is possible because hash tables use the semi-colon as key-value-pair separators, leaving the comma available to create classic arrays:

```
# Create hash table with arrays as value:
$test = @{ value1 = 12; value2 = 1,2,3 }
# Return values (value 2 is an array with three elements):
$test.value1

  12

$test.value2
```

```
1
2
3
```

Inserting New Keys in an Existing Hash Table

If you'd like to insert new key-value pairs in an existing hash table, just specify the new key and the value that is to be assigned to the new key. Again, you can choose between the square brackets and dot notations.

```
# Create a new hash table with key-value pairs
$list = @{Name = "PC01"; IP="10.10.10.10"; User="Tobias Weltner"}
# Insert two new key-value pairs in the list (two different
# notations are possible):
$list.Date = Get-Date
$list["Location"] = "Hanover"
# Check result:
$list

  Name                           Value
  ----                           -----
  Name                           PC01
  Location                       Hanover
  Date                           08/21/2007 13:00:18
  IP                             10.10.10.10
  User                           Tobias Weltner
```

Because it's easy to insert new keys in an existing hash table you can create empty hash tables and then insert keys as needed:

```
# Create empty hash table
$list = @{}
# Subsequently insert key-value pairs when required
$list.Name = "PC01"
$list.Location = "Hanover"
(...)
```

Modifying and Removing Values

If all you want to do is to change the value of an existing key in your hash table, just overwrite the value:

```
# Overwrite the value of an existing key with a new value (two possible notations):
$list["Date"] = (Get-Date).AddDays(-1)
$list.Location = "New York"

  Name                           Value
  ----                           -----
  Name                           PC01
```

```
    Location                        New York
    Date                            08/20/2007 13:10:12
    IP                              10.10.10.10
    User                            Tobias Weltner
```

If you'd like to completely remove a key from the hash table, use *Remove()* and as an argument specify the key that you want to remove:

```
$list.remove("Date")
```

Using Hash Tables for Output Formatting

An interesting use for hash tables is to format text. Normally, PowerShell outputs the result of most commands as a table and internally uses the cmdlet *Format-Table*:

```
# Both lines return the same result:
Dir
Dir | Format-Table
```

If you use *Format-Table*, you can pass it a hash table with formatting specifications. This enables you to control how the result of the command is formatted.

Every column is defined with its own hash table. In the hash table, values are assigned to the following four keys:

- **Expression:** The name of object property to be displayed in this column
- **Width:** Character width of the column
- **Label:** Column heading
- **Alignment:** Right or left justification of the column

All you need to do is to pass your format definitions to *Format-Table* to ensure that your listing shows just the name and date of the last modification in two columns:

```
# Setting formatting specifications for each column in a hash table:
$column1 = @{expression="Name"; width=30; `
  label="filename"; alignment="left"}
$column2 = @{expression="LastWriteTime"; width=40; `
  label="last modification"; alignment="right"}
# Output contents of a hash table:
$column1

  Name                            Value
  ----                            -----
  alignment                       left
  label                           File name
  width                           30
  expression                      Name

# Output Dir command result with format table and
# selected formatting:
```

```
Dir | Format-Table $column1, $column2

  File Name           Last Modification
  ---------           ----------------
  Application Data    10/1/2007  16:09:57
  Backup              07/26/2007 11:03:07
  Contacts            04/13/2007 15:05:30
  Debug               06/28/2007 18:33:29
  Desktop             10/4/2007  14:21:20
  Documents           10/4/2007  21:23:10
  (...)
```

You'll learn more about format cmdlets like *Format-Table* in the Chapter 5.

Copying Arrays and Hash Tables

Copying arrays or hash tables from one variable to another works, but may produce unexpected results. The reason is that arrays and hash tables are not stored directly in variables, which always store only a single value. When you work with arrays and hash tables, you are dealing with a *reference* to the array or hash table. So, if you copy the contents of a variable to another, only the reference will be copied, not the array or the hash table. That could result in the following unexpected behavior:

```
$array1 = 1,2,3
$array2 = $array1
$array2[0] = 99
$array1[0]

  99
```

Although the contents of *$array2* were changed in this example, this affects *$array1* as well, because they are both identical. The variables *$array1* and *$array2* internally reference the same storage area. Therefore, you have to create a copy if you want to copy arrays or hash tables,:

```
$array1 = 1,2,3
$array2 = $array1.Clone()
$array2[0] = 99
$array1[0]

  1
```

Whenever you add new elements to an array (or a hash table) or remove existing ones, a copy action takes place automatically in the background and its results are stored in a new array or hash table. The following example clearly shows the consequences:

```
# Create array and store pointer to array in $array2:
$array1 = 1,2,3
$array2 = $array1
# Assign a new element to $array2. A new array is created in the process and stored
in $array2:
```

```
$array2 += 4
$array2[0]=99
# $array1 continues to point to the old array:
$array1[0]

  1
```

Strongly Typed Arrays

Arrays are typically polymorphic: you can store any type of value you want in any element. PowerShell automatically selects the appropriate type for each element. If you want to limit the type of data that can be stored in an array, use "strong typing" and predefine a particular type. You should specify the desired variable type in square brackets. You also specify an open and closed square bracket behind the variable type because this is an array and not a normal variable:

```
# Create a strongly typed array that can store whole numbers only:
[int[]]$array = 1,2,3
# Everything that can be converted into a number is allowed
# (including strings):
$array += 4
$array += 12.56
$array += "123"
# If a value cannot be converted into a whole number, an error
# will be reported:
$array += "Hello"

  The value "Hello" cannot be converted into the type "System.Int32".
  Error: "Input string was not in a correct format."
  At line:1 char:6
  + $array  <<<< += "Hello"
```

In the example, *$array* was defined as an array of the *Integer* type. Now, the array is able to store only whole numbers. If you try to store values in it that cannot be turned into whole numbers, an error will be reported.

Summary

Arrays and hash tables can store as many separate elements as you like. Arrays assign a sequential index number to elements that always begin at 0. Hash tables in contrast use a key name. That's why every element in hash tables consists of a key-value pair.

You create new arrays with *@(Element1, Element2, ...)*. You can also leave out *@()* for arrays and only use the comma operator. You create new hash tables with *@{key1=value1;key2=value2; ...)*. @{} must always be specified for hash tables. Semi-colons by themselves are not sufficient to create a new hash table.

You can address single elements of an array or hash able by using square brackets. Specify either the index number (for arrays) or the key (for hash tables) of the desired element in the square brackets. Using this approach you can select and retrieve several elements at the same time.

CHAPTER 5.

The PowerShell Pipeline

The PowerShell pipeline chains together a number of commands similar to a production assembly. So, one command hands over its result to the next, and at the end, you receive the result.

Topics Covered:

Using the PowerShell Pipeline

Instruction chains are really nothing new. The old console was able to forward (or "pipe") the results of a command to the next with the "pipe" operator "|". One of the more known usages was to pipe data to the tool *more,* which then would present the data screen page by screen page:

```
Dir | more
```

In contrast to the traditional concept of text piping, the PowerShell pipeline takes an object-oriented approach and implements it in real time. Have a look:

```
Dir | Sort-Object Length | Select-Object Name, Length |
  ConvertTo-Html | Out-File report.htm
.\report.htm
```

It returns an HTML report on the current directory contents sorted by file size. All of this starts with a *Dir* command, which then passes its result to *Sort-Object*. The sorted result then gets limited to only the properties you want in the report. *ConvertTo-Html* converts the objects to HTML which is then written to a file.

Object-oriented Pipeline

What you see here is a true object-oriented pipeline so the results from a command remain rich objects. Only at the end of the pipeline will the results be reduced to text or HTML or whatever you choose for output. Take a look at *Sort-Object*. It sorts the directory listing by file size. If the pipeline had simply fed plain text into *Sort-Object*, you would have had to tell *Sort-Object* just where the file size information was to be found in the raw text. You would also have had to tell *Sort-Object* to sort this information numerically and not alphabetically. Not so here. All you need to do is tell *Sort-Object* which object property you want to sort. The object nature tells *Sort-Object* all it needs to know: where the information you want to sort is found, and whether it is numeric or letters.

You only have to tell *Sort-Object* which object property to use for sorting because PowerShell sends results as rich .NET objects through the pipeline. *Sort-Object*does all the rest automatically. Simply replace *Length* with another object property, such as *Name* or *LastWriteTime*, to sort according to these criteria. Unlike text, information in an object is clearly structured: this is a crucial PowerShell pipeline advantage.

Text Not Converted Until the End

The PowerShell pipeline is always used, even when you provide only a single command. PowerShell attaches to your input the cmdlet *Out-Default* which converts the resulting objects into text at the end of the pipeline.

Even a simple *Dir* command is appended internally and converted into a pipeline command:

```
Dir | Out-Default
```

Of course, the real pipeline benefits show only when you start adding more commands. The chaining of several commands allows you to use commands like Lego building blocks to assemble a complete solution from single commands. The following command would output only a directory's text files listing in alphabetical order:

```
Dir *.txt | Sort-Object
```

The cmdlets in Table 5.1 have been specially developed for the pipeline and the tasks frequently performed in it. They will all be demonstrated in the following pages of this chapter.

note

Just make sure that the commands you use in a pipeline actually do process information from the pipeline. The following line, while it is technically OK, is really useless because *notepad.exe* cannot process pipeline results:

```
Dir | Sort-Object | notepad
```

If you'd like to open pipeline results in an editor, you should put the results in a file first and then open the file with the editor:

```
Dir | Sort-Object | Out-File result.txt; notepad result.txt
```

Cmdlet/Function	**Description**
Compare-Object	Compares two objects or object collections and marks their differences
ConvertTo-Html	Converts objects into HTML code
Export-Clixml	Saves objects to a file (serialization)
Export-Csv	Saves objects in a comma-separated values file

ForEach-Object	Returns each pipeline object one after the other
Format-List	Outputs results as a list
Format-Table	Outputs results as a table
Format-Wide	Outputs results in several columns
Get-Unique	Removes duplicates from a list of values
Group-Object	Groups results according to a criterion
Import-Clixml	Imports objects from a file and creates objects out of them (deserialization)
Measure-Object	Calculates the statistical frequency distribution of object values or texts
more	Returns text one page at a time
Out-File	Writes results to a file
Out-Host	Outputs results in the console
Out-Host -paging	Returns text one page at a time
Out-Null	Deletes results
Out-Printer	Sends results to printer
Out-String	Converts results into plain text
Select-Object	Filters properties of an object and limits number of results as requested
Sort-Object	Sorts results
Tee-Object	Copies the pipeline's contents and saves it to a file or a

	variable
Where-Object	Filters results according to a criterion

Table 5.1: Typical pipeline cmdlets and functions

Streaming: Real-time Processing or Not?

When you combine several commands in a pipeline, you'll want to ask *when* each separate command will actually be processed: consecutively or at the same time? The pipeline processes the results in real time, at least when the commands chained together in the pipeline support real-time processing. That's why there are two pipeline modes:

- **Sequential (slow) mode:** In sequential mode, pipeline commands are executed one at a time. So the command's results are passed on to the next one only after the command has completely performed its task. This mode is slow and hogs memory because results are returned only after all commands finish their work and the pipeline has to store the entire results of each command. The sequential mode basically corresponds to the variable concept that first saves the result of a command to a variable before forwarding it to the next command.
- **Streaming Mode (quick):** The streaming mode immediately processes each command result. Every single result is directly passed onto the subsequent command. It rushes through the entire pipeline and is immediately output. This quick mode saves memory because results are output while the pipeline commands are still performing their tasks. The pipeline doesn't have to store all of the command's results, but only one single result at a time.

"Blocking" Pipeline Commands

You can sort pipeline results through a blocking operation because sorting can only take place when all results are available. This also means there can be long processing times and it can even cause instability if you don't pay attention to memory requirements:

```
# Attention: danger!
Dir C:\ -recurse | Sort-Object
```

important

If you execute this extreme example, you won't see any signs of life from PowerShell for a long time. If you let the command run too long, you may even lose control of your computer and have to reboot it because it runs out of memory. What's going on here?

In this example *Dir* returns all files and directors of C:\. These results are passed by the pipeline to *Sort-Object*, and because *Sort-Object*can only sort the results when all of them are available, it collects the results as they come in. Those results then create a "data jam" in the pipeline. The two problem areas in sequential mode are:

First problem: You won't see any activity as long as data is being collected. The more data that has to be acquired, the longer the wait time will be. In the above example, it can take several minutes.

Second problem: Because enormous amounts of data have to be stored temporarily before *Sort-Object* can process them, the memory space requirement is very high. In this case, it's even higher that the entire Windows system will respond more and more clumsily until finally you won't be able to control it any longer.

That's not all. In this specific case, confusing error messages will pile up: if you have *Dir* output a complete recurse folder listing, it may encounter subdirectories where you have no access rights. This will lead to (benign) error messages that will always be immediately output. Since the results of the *Dir* command are passed along the pipeline to the following command, which collects it before outputting it, error messages will appear out of the blue.

So, if you use sequential pipeline commands like Sort-Object, which block the pipeline and wait for all results, make sure the pipeline is not processing excessive amount of data.

Whether a command supports streaming is up to the programmer. For *Sort-Object*, there are technical reasons why this command must first wait for all results. Otherwise, it wouldn't be able to sort the results. If you use commands that are not designed for PowerShell then clearly their original programmers could not have taken into account the special demands of PowerShell. For example, if you use the traditional command *more.com* to output information one page at a time, it will work but *more.com* is also a blocking command that could interrupt pipeline streaming:

```
# If the preceding command can execute its task quickly,
# you may not notice that it can be a block:
Dir | more.com
# If the preceding command requires much time,
# its blocking action may cause issues:
Dir c:\ -recurse | more.com
```

But also genuine PowerShell cmdlets, functions, or scripts can block pipelines if the programmer doesn't use streaming. Surprisingly, PowerShell developers forgot to add streaming support to the integrated *more* function. This is why *more* essentially doesn't behave much differently than the ancient *more.com* command:

```
# The more function doesn't support streaming, either,
# and that means you'll have to wait:
Dir c:\ -recurse | more
```

The cmdlet *Out-Host* means you don't have to wait. Its parameter *-paging* also supports page-by-page outputs. Because this cmdlet supports streaming, you won't have to sit in front of the console twiddling your thumbs:

```
Dir c:\ -recurse | Out-Host -paging
```

tip

In Chapters 9 and 10, you'll learn what a programmer has to watch out for so that PowerShell cmdlets, functions, or scripts will support the pipeline streaming mode.

Converting Objects into Text

At the end of a day, you want commands to return visible results, not objects. So, while results stay rich data objects while traveling the pipeline, at the end of the pipeline, they must be converted into text. This is done by (internally) adding *Out-Default* to your input. The following commands are identical:

```
Dir
Dir | Out-Default
```

Out-Default transforms the pipeline result into visible text. To do so, it first calls *Format-Table* (or *Format-List* when there are more than five properties to output) internally, followed by *Out-Host*. *Out-Host* outputs the text in the console. So, this is what happens internally:

```
Dir | Format-Table | Out-Host
```

Making Object Properties Visible

To really see all the object properties and not just the ones PowerShell "thinks" are important, use *Format-Table* and add a "*" to select all object properties.

```
Dir | Format-Table *

  PSPat PSPar PSChi PSDri PSPro PSIsC Mode Name Pare Exis Root Full
  h     entPa ldNam ve    vider ontai           nt   ts        Name
        th    e                  ner


  ----- ----- ----- ----- ----- ----- ---- ---- ---- ---- ---- ----
  Mi... Mi... Ap... C     Mi...  True d... A... T... True C:\  C...
  Mi... Mi... Ba... C     Mi...  True d... B... T... True C:\  C...
  Mi... Mi... Co... C     Mi...  True d... C... T... True C:\  C...
  Mi... Mi... Debug C     Mi...  True d... D... T... True C:\  C...
  Mi... Mi... De... C     Mi...  True d... D... T... True C:\  C...
```

You now get so much information that columns shrink to an unreadable format.

For example, if you'd prefer not to reduce visual display because of lacking space, use the *-wrap* parameter, like this:

```
Dir | Format-Table * -wrap
```

Still, the horizontal table design is unsuitable for more than just a handful of properties. This is why PowerShell uses *Format-List* instead of *Format-Table* whenever there are more than five properties to display, and you should do the same:

```
Dir | Format-List *
```

You will now see a list of several lines for each object's property. For a folder, it might look like this:

```
PSPath              : Microsoft.PowerShell.Core\FileSystem::C:\
                      Users\Tobias Weltner\Music
PSParentPath        : Microsoft.PowerShell.Core\FileSystem::C:\
                      Users\Tobias Weltner
PSChildName         : Music
PSDrive             : C
PSProvider          : Microsoft.PowerShell.Core\FileSystem
PSIsContainer       : True
Mode                : d-r--
Name                : Music
Parent              : Tobias Weltner
Exists              : True
Root                : C:\
FullName            : C:\Users\Tobias Weltner\Music
Extension           :
CreationTime        : 13.04.2007 01:54:53
CreationTimeUtc     : 12.04.2007 23:54:53
LastAccessTime      : 10.05.2007 21:37:26
LastAccessTimeUtc   : 10.05.2007 19:37:26
LastWriteTime       : 10.05.2007 21:37:26
LastWriteTimeUtc    : 10.05.2007 19:37:26
Attributes          : ReadOnly, Directory
```

A file has slightly different properties:

```
PSPath              : Microsoft.PowerShell.Core\FileSystem::C:\
                      Users\Tobias Weltner\views.PS1
PSParentPath        : Microsoft.PowerShell.Core\FileSystem::C:\
                      Users\Tobias Weltner
PSChildName         : views.PS1
PSDrive             : C
PSProvider          : Microsoft.PowerShell.Core\FileSystem
PSIsContainer       : False
Mode                : -a---
```

```
  Name              : views.PS1
  Length            : 4045
  DirectoryName     : C:\Users\Tobias Weltner
  Directory         : C:\Users\Tobias Weltner
  IsReadOnly        : False
  Exists            : True
  FullName          : C:\Users\Tobias Weltner\views.PS1
  Extension         : .PS1
  CreationTime      : 18.09.2007 16:30:13
  CreationTimeUtc   : 18.09.2007 14:30:13
  LastAccessTime    : 18.09.2007 16:30:13
  LastAccessTimeUtc : 18.09.2007 14:30:13
  LastWriteTime     : 18.09.2007 16:46:12
  LastWriteTimeUtc  : 18.09.2007 14:46:12
  Attributes        : Archive
```

The property names are located on the left and their content on the right. You now know how to find out which properties an object contains.

Formatting Pipeline Results

Transforming objects produced by the pipeline is carried out by formatting cmdlets. There are four choices:

```
Get-Command -verb format

  CommandType  Name           Definition
  -----------  ----           ----------
  Cmdlet       Format-Custom  Format-Custom [[-Property] <Objec...
  Cmdlet       Format-List    Format-List [[-Property] <Object[...
  Cmdlet       Format-Table   Format-Table [[-Property] <Object...
  Cmdlet       Format-Wide    Format-Wide [[-Property] <Object>...
```

These formatting cmdlets are not just useful for converting all of an object's properties into text but you can also select the properties you want to see.

Displaying Particular Properties

To do so, you should type the property that you want to see and not just an asterisk behind the cmdlet. The next instruction gets you a directory listing with only *Name* and *Length*. Because subdirectories don't have a property called *Length*, the *Length* column for the subdirectory is empty:

```
Dir | Format-Table Name, Length

  Name                 Length
  ----                 ------
  Sources
  Test
  172.16.50.16150.dat  16
```

```
    172.16.50.17100.dat  16
    output.htm           10834
    output.txt           1338
```

Using Wildcard Characters

Wildcard characters are allowed so the next command outputs all running processes that begin with "I". All properties starting with "pe" and ending in "64" are output:

```
  Get-Process i* | Format-Table name,pe*64

    Name           PeakPagedMemory  PeakWorkingSet64  PeakVirtualMemory
                   Size64                             Size64
    ----           ---------------  ----------------  -----------------
    IAAnotif               3432448           6496256           81596416
    IAANTmon                761856           2363392           25346048
    Idle                         0                 0                  0
    ieuser                12193792          25616384          180887552
    iexplore              37224448          52764672          203845632
    IfxPsdSv               1396736           3436544           43646976
    IFXSPMGT               3670016           9932800           73412608
    IFXTCS                 3375104           7675904           72654848
    iPodService            3231744           5177344           57401344
    iTunesHelper           2408448           5935104           70582272
```

If you want to use even more complex wildcards, regular expressions are permitted (more information coming in Chapter 13). For example, WMI objects that are returned by *Get-WmiObject* contain a number of properties that PowerShell returns and that all begin with the "__" character. To exclude these properties, you should use a wildcard like this one:

```
  Get-WmiObject Win32_Share | Format-List [a-z]*

    Status         : OK
    Type           : 2147483648
    Name           : ADMIN$
    AccessMask     :
    AllowMaximum   : True
    Caption        : Remote Admin
    Description    : Remote Admin
    InstallDate    :
    MaximumAllowed :
    Path           : C:\Windows
    Status         : OK
    Type           : 2147483648
    Name           : C$
    AccessMask     :
    AllowMaximum   : True
    Caption        : Default share
    Description    : Default share
    InstallDate    :
    MaximumAllowed :
```

```
  Path            : C:\
  (...)
```

Scriptblocks and "Synthetic" Properties

Scriptblocks can be used as columns as they basically act as PowerShell instructions included in braces that work like synthetic properties to calculate their value. Within a scriptblock, the variable $_ contains the actual object. The scriptblock could convert the *Length* property into kilobytes if you'd like to output file sizes in kilobytes rather than bytes:

```
Dir | Format-Table Name, { [int]($_.Length/1KB) }

  Name         [int]($_.Length/1KB)
  ----         --------------------
  output.htm                     11
  output.txt                     13
  backup.pfx                      2
  cmdlet.txt                     23
```

Or perhaps you'd like your directory listing to denote how many days have passed since a file or a subdirectory was last modified. While the file object doesn't furnish such information, you could calculate this by means of available properties and provide it its own new property. In the *LastWriteTime* property, the date of the last modification is indicated. By using the *New-TimeSpan* cmdlet, you can calculate how much time has elapsed up to the current date. To see how this works, look at the line below as an example that calculates the time difference between January 1, 2000, and the current date:

```
New-TimeSpan "01/01/2000" (Get-Date)

  Days              : 2818
  Hours             : 11
  Minutes           : 59
  Seconds           : 3
  Milliseconds      : 699
  Ticks             : 2435183436996134
  TotalDays         : 2818,49934837516
  TotalHours        : 67643,9843610037
  TotalMinutes      : 4058639,06166022
  TotalSeconds      : 243518343,699613
  TotalMilliseconds : 243518343699,613
```

Use this scriptblock to output how many days have elapsed from the *LastWriteTime* property up to the current date and to read it out in its own column:

```
{(New-TimeSpan $_.LastWriteTime (Get-Date)).Days}
```

Dir would then return a subdirectory listing that shows how old the file is in days:

```
Dir | Format-Table Name, Length, `
  {(New-TimeSpan $_.LastWriteTime (Get-Date)).Days} -autosize
```

```
    Name               Length (New-TimeSpan
                              $_.LastWriteTime
                              (Get-Date)).Days
    ----               ------ ----------------
    Application Data                       61
    Backup                                 55
    Contacts                              158
    Debug                                  82
    Desktop                                19
    Documents                               1
    (...)
```

Changing Column Headings

As you use synthetic properties, you'll notice that column headings look strange because PowerShell puts code in them that computes the column contents. However, after reading the last chapter, you know that you can use a hash table to format columns more effectively and that you can also rename them:

```
  $column = @{Expression={ [int]($_.Length/1KB) }; Label="KB" }
  Dir | Format-Table Name, $column

    Name         KB
    ----         --
    output.htm   11
    output.txt   13
    backup.pfx    2
    cmdlet.txt   23
```

Optimizing Column Width

Text output conforms to the width of your PowerShell console's display buffer as it tries to accommodate as much data as possible. Because the pipeline processes results in real time, *Format-Table* cannot know how wide of a space the column elements will occupy. As a result, the cmdlet tends to be generous in sizing columns. If you specify the *-auto* parameter, *Format-Table* will collect all results first before setting the maximum width for all elements. You can optimize output, but the results will no longer be output in real time:

```
  $column = @{Expression={ [int]($_.Length/1KB) }; Label="KB" }
  Dir | Format-Table Name, $column -auto

    Name         KB
    ----         --
    output.htm   11
    output.txt   13
    backup.pfx    2
    cmdlet.txt   23
```

PropertySets and Views

If you don't specify any particular properties behind the formatting cmdlet, PowerShell will determine which object properties to convert into text. This automatic feature comes from what is known as the Extended Type System (ETS), which you'll learn more about a bit later. For many commands, PowerShell supplies *PropertySets,*which are compilations of especially important object properties. They make it unnecessary to specify properties manually, yet still receive basic information.

If you output the result of *Get-Process* without further specifications, PowerShell will routinely convert the following *Process* properties objects into text:

```
Get-Process

  Handles  NPM(K)  PM(K)  WS(K)  VM(M)  CPU(s)    Id  ProcessName
  -------  ------  -----  -----  -----  ------    --  -----------
       36       2    712     48     21          2616  agrsmsvc
      328       9  16620   3752    114           464  AppSvc32
      105       3   1044    592     37          1228  Ati2evxx
```

You can set quite a different priority by specifying a *PropertySet* like *PSResources* after *Format-Table*:

```
Get-Process | Format-Table PSResources

  Name        Id  Handle  Working  PagedMem  Private   VirtualMe Total
                  Count   Set      orySize   Memory    morySize  Process
                                             Size      or Time
  ----        --  ------  -------  --------  --------  --------- -------
  agrsmsvc  2616      36    49152    729088    729088   21884928
  AppSvc32   464     328  3842048  17018880  17018880  119091200
  Ati2evxx  1228     105   606208   1069056   1069056   38473728
  Ati2evxx  1732     130  3743744   2097152   2097152   50249728
  ATSwpNav  2064      79  1069056   4808704   4808704   60739584   00:09
  (...)
```

And PowerShell will select other properties when you use the *PropertySet PSConfiguration*:

```
Get-Process | Format-Table PSConfiguration

  Name        Id PriorityClass  FileVersion
  ----        -- -------------  -----------
  agrsmsvc  2616
  AppSvc32   464
  Ati2evxx  1228
  Ati2evxx  1732
  ATSwpNav  2064 Normal         7, 7, 0, 25
```

This raises the question of what exactly is a *PropertySet* and how to find out what they are about. *PropertySets* are defined for each cmdlet. If you want to see which *PropertySets* are available for the *Get-Process* cmdlet, use G*et-Member* to list all members of the *PropertySet* type:

```
Get-Process | Get-Member -MemberType PropertySet


   TypeName: System.Diagnostics.Process
   Name             MemberType  Definition
   ----             ----------  ----------
   PSConfiguration  PropertySet PSConfiguration {Name, Id,
                                PriorityClass, FileVersion}
   PSResources      PropertySet PSResources {Name, Id, Handlecount,
                                WorkingSet, NonPagedMemorySize,
                                PagedMemory...
```

The properties that make a *PropertySet*visible are listed after the respective *PropertySet*. As you see, two *PropertySets* exist for the *Get-Process* cmdlet. No practical *PropertySets* are defined for most other cmdlets, but you make up for that. In the section about the ETS toward the end of this chapter, you'll learn how to define a command's properties that are most important for you as a *PropertySet*.

Views work in a similar way as they set not just the properties that are to be converted into text, but they can also specify column names or widths and even group information.

```
# All running processes grouped after start time:
Get-Process | Format-Table -view StartTime
# All running processes grouped according to priority:
Get-Process | Format-Table -view Priority
```

Views are highly specific and always apply to particular object types and particular formatting cmdlets. The *Priority* view applies only to *Format-Table* and only when you display *Process* objects with it. This view doesn't work for *Format-List*:

```
Get-Process | Format-List -view Priority

   Format-List : View name Priority cannot be found.
   At line:1 char:26
   + Get-Process | Format-List  <<<< -view Priority
```

You'll get an error message if you try to use it to format a file listing and not processes,:

```
Dir | Format-Table -view Priority

   Format-Table : View name Priority cannot be found.
   At line:1 char:19
   + Dir | Format-Table  <<<< -view Priority
```

Unfortunately, there is no built-in option for finding out which views are available. In the section on the ETS, you'll learn solutions to this problem, and you'll also read about how to define your own views.

Sorting and Grouping Pipeline Results

Your first task is to process and concentrate this information since PowerShell commands often return large amounts of data. Using the cmdlets *Sort-Object* and *Group-Object*, you can sort and group other command results. In the simplest scenario, just append *Sort-Object* to a pipeline command and your output will already be sorted. It's really very simple:

```
Dir | Sort-Object
```

When you do that, *Sort-Object* selects the property it uses for sorting. It's better to choose the sorting criterion yourself as every object property may be used as a sorting criterion. For example, you could use one to create a descending list of a subdirectory's largest files:

```
Dir  | Sort-Object -property Length -descending
```

tip

So that you can make good use of *Sort-Object* and all the other following cmdlets, you must also know which properties are available for the objects traveling through the pipeline. In the last section, you learned how to do that. Send the result of *Dir* to *Format-List* * first, then you'll see all properties and you can select one to use for subsequent sorting:

```
Dir | Format-List *
```

The parameter *-property* allows you to use any object property as a sorting criterion. In this case, *Length* is used and *Sort-Object* does the rest of the work itself. You need only describe where the file size is located (it is clearly available in the *Length* object property). You do not have to state explicitly that the file size is numeric and so has to be sorted numerically, not alphabetically. *Sort-Object* can sort by more than one property at the same time. For example, if you'd like to alphabetize all the files in a subdirectory by type first (*Extension* property) and then by name (*Name* property), specify both properties:

```
Dir | Sort-Object Extension, Name
```

Sort Object and Hash Tables

Sort-Object not only uses properties for sorting operations. You may also use hash tables as an alternative. Let's assume that you want to sort a subdirectory listing by file size and name, while the file size must be sorted in descending and names in ascending order. How do you accomplish that? In any case, not like this:

```
Dir | Sort-Object Length, Name -descending, -ascending

   Sort-Object : A parameter could not be found that matches
   parameter name "System.Object[]".
   At line:1 char:18
```

```
    + Dir | Sort-Object  <<<< Length, Name -descending, -ascending
```

You can solve this problem by passing *Sort-Object* to a hash table (see Chapter 4).

```
Dir | Sort-Object @{expression="Length";Descending=$true}, `
  @{expression="Name";Ascending=$true}
```

The hash table makes it possible to append additional information to a property, so you can separately specify for each property the sorting sequence you prefer.

Apropos hash tables: can you sort these, too? At first glance, it would seem so:

```
$hash=@{"Tobias"=90;"Martina"=90;"Cofi"=80;"Zumsel"=100}
$hash | Sort-Object Value -descending

  Name                          Value
  ----                          -----
  Tobias                        90
  McGuffin                      100
  Cofi                          80
  Martina                       90
```

Yet it does work if you pass the enumerator directly to *Sort-Object*. This is what you'll get with *GetEnumerator()*:

```
$hash.GetEnumerator() | Sort-Object Value -descending

  Name                          Value
  ----                          -----
  Zumsel                        100
  Martina                       90
  Tobias                        90
  Cofi                          80
```

Grouping Information

Group-Object works by grouping similar objects and then reporting their number. You only need specify the property to *Group-Object* as your grouping criterion. The next line returns a good status overview of services:

```
Get-Service | Group-Object Status

  Count  Name     Group
  -----  ----     -----
     91  Running  {AeLookupSvc, AgereModemAudio, Appinfo, Ati
                  External Event Utility...}
     67  Stopped  {ALG, AppMgmt, Automatic LiveUpdate - Scheduler,
                  BthServ...}
```

In this case, *Group-Object* returns an object for every group. The number of groups depends only on how many different values could be found in the property specified in the grouping operation. The *Status* property always returns either the values "running" or "stopped" for services. This is why *Group-Object* returned exactly two objects in this example.

The results' object always contains the properties *Count*, *Name*, and *Group*. Services are grouped according to the desired criteria in the *Group* property. The following shows how you could obtain a list of all currently running services:

```
$result = Get-Service | Group-Object Status
$result[0].Group
```

It works in a very similar way for other objects. In a file system, *Group-Object* would put file types in a subdirectory and list their frequency if you use *Extension* as grouping property:

```
Dir | Group-Object Extension
```

Of course, you could subsequently also sort the result:

```
Dir | Group-Object Extension | Sort-Object Count -descending

  Count  Name  Group
  -----  ----  -----
     22        {Application Data, Backup, Contacts, Debug...}
     16  .ps1  {filter.ps1, findview.PS1, findview2.PS1, findvi...}
     12  .txt  {output.txt, cmdlet.txt, ergebnis.txt, error.txt...}
      4  .csv  {ergebnis.csv, history.csv, test.csv, test1.csv}
      3  .bat  {ping.bat, safetycopy.bat, test.bat}
      2  .xml  {export.xml, now.xml}
      2  .htm  {output.htm, report.htm}
```

Using Grouping Expressions

Group-Object not only groups by set properties but also can use PowerShell expressions. These must be specified in braces behind *Group-Object*. The respective object is within the expression as is customary for a *$_* variable. The expression can report back on any results. Then *Group-Object* groups the objects accordingly.

In the following line, the expression returns *True* if the file size exceeds 100 KB or *False* as the line returns two groups, *True* and *False*. All files larger than 100KB are in the *True* group:

```
Dir | Group-Object {$_.Length -gt 100KB}

  Count  Name   Group
  -----  ----   -----
     67  False  {Application Data, Backup, Contacts, Debug...}
      2  True   {export.xml, now.xml} in the column Count...
```

However, the expression's return value doesn't have to be either *True* or *False*, but is arbitrary. In the next line, the expression determines the file name's first letter and returns this in capitals. The result: *Group-Object* groups the subdirectory contents by first letters:

```
Dir | Group-Object {$_.name.SubString(0,1).toUpper()}

  Count  Name  Group
  -----  ----  -----
      4  A     {Application Data, alias1, output.htm, output.txt}
      2  B     {Backup, backup.pfx}
      2  C     {Contacts, cmdlet.txt}
      5  D     {Debug, Desktop, Documents, Downloads...}
      5  F     {Favorites, filter.ps1, findview.PS1, findview2.PS1...}
      3  L     {Links, layout.lxy, liste.txt}
      3  M     {MSI, Music, meinskript.ps1}
      3  P     {Pictures, p1.nrproj, ping.bat}
      7  S     {Saved Games, Searches, Sources, SyntaxEditor...}
     15  T     {Test, test.bat, test.csv, test.ps1...}
      2  V     {Videos, views.PS1}
      1  [     {[test]}
      1  1     {1}
      4  E     {result.csv, result.txt, error.txt, export.xml}
      4  H     {mainscript.ps1, help.txt, help2.txt, history.csv}
      1  I     {info.txt}
      2  N     {netto.ps1, now.xml}
      3  R     {countfunctions.ps1, report.htm, root.cer}
      2  U     {unsigned.ps1, .ps1}
```

If you take a closer look at the *Group-Object* result, you'll notice that after each group name is an array in which single group objects are summarized. So, you could output a practical, alphabetically grouped directory view from this result:

```
Dir | Group-Object {$_.name.SubString(0,1).toUpper()} |
  ForEach-Object { ($_.Name)*7; "======="; $_.Group}

  (...)
  BBBBBBB
  =======
  d----        26.07.2007     11:03            Backup
  -a---        17.09.2007     16:05        1732 backup.pfx
  CCCCCCC
  =======
  d-r--        13.04.2007     15:05            Contacts
  -a---        13.08.2007     13:41       23586 cmdlet.txt
  DDDDDDD
  =======
  d----        28.06.2007     18:33            Debug
  d-r--        30.08.2007     15:56            Desktop
  d-r--        17.09.2007     13:29            Documents
  d-r--        24.09.2007     11:22            Downloads
  -a---        26.04.2007     11:43        1046 drive.vbs
  (...)
```

Of course, it will cost a little memory space to store the grouped objects in arrays. Use the parameter *-noelement* if you don't need the grouped objects.. You could then receive a quick listing of how many processes of which companies are running on your computer. However, because of the *-noelement* parameter, you will not be able to see any longer which processes these are in detail:

```
Get-Process | Group-Object -property Company -noelement

  Count Name
  ----- ----
     50
      1 AuthenTec, Inc.
      2 LG Electronics Inc.
      1 Symantec Corporation
      2 ATI Technologies Inc.
     30 Microsoft Corporation
      1 Adobe Systems, Inc.
      1 BIT LEADER
      1 LG Electronics
      1 Intel Corporation
      2 Apple Inc.
      1 BlazeVideo Company
      1 ShellTools LLC
      2 Infineon Technologies AG
      1 Just Great Software
      1 Realtek Semiconductor
      1 Synaptics, Inc.
```

Using Formatting Cmdlets to Form Groups

Group-Object isn't the only option for grouping information. Formatting cmdlets like *Format-Table* or *Format-List* can also group information if you use the *-groupBy* parameter. You can specify the property that you want to use as a grouping criterion after it. For example, if you'd like to group a subdirectory's contents by file type, use the *Extension* property:

```
Dir | Format-Table -groupBy Extension
```

The result appears to be correct at first glance. However, if you look more carefully, you'll find many groups repeated as *Format-Table* tried not to disrupt the streaming pipeline and processed the files unleashed by *Dir* running through the pipeline in real time. This leads to a continual accumulation of new groups as files pass through the pipeline that no longer fit into the current group. So, if you want to form groups, you will need to interrupt pipeline streaming and sort the files first, based on the criterion you want to group them afterwards:

```
Dir | Sort-Object Extension, Name | Format-Table -groupBy Extension


  Directory: Microsoft.PowerShell.Core\FileSystem::C:\Users\
  Tobias Weltner
  Mode                LastWriteTime     Length Name
  ----                -------------     ------ ----
  -a---        10.08.2007     11:28        116 ping.bat
```

```
    -a---         18.09.2006     23:43          24 backupcopy.bat
    -a---         15.08.2007     20:00         569 test.bat
    Directory: Microsoft.PowerShell.Core\FileSystem::C:\Users\
    Tobias Weltner
    Mode                LastWriteTime     Length Name
    ----                -------------     ------ ----
    -a---         15.08.2007     08:44         307 history.csv
    -a---         15.08.2007     09:35        8160 test.csv
```

tip

In this example, the result of *Dir* is directly sorted by *Sort-Object* according to two properties, first by extension and then by name. The result is that the groups are sorted alphabetically by name.

Filtering Pipeline Results

Pipeline filters allow only certain objects or object properties through the pipeline. That's practical, because often you will want all results that a command returns. *Where-Object* permits only those objects to pass through that meet certain criterion. *Select-Object* also allows only certain object properties to travel through the pipeline. You can use *ForEach-Object* to process all objects in the pipeline sequentially, enabling you to make your own filters. Finally, *Get-Unique* removes pipeline duplicates. Let's take a closer look at filters.

Filtering Objects Out of the Pipeline

If you're only interested in certain objects, assign *Where-Object* the task of closely examining all objects and allowing only those through that meet your criterion, which consists of object properties. For example, if you don't want to view all services returned by *Get-Service*, but only currently running services, you'll first have to know which service object property reveals whether the service is running or not. You will need more detailed knowledge about the properties supported by an object.

You already know how to ferret out these properties. If you'll recall, *Format-List* neatly lists all of an object's properties when you use the asterisk character as an argument. You will only need an object example that you can examine with *Format-List*.

To do so, use the same command that you will want to use later in your pipeline, such as *Get-Service* and save its result to a variable. As commands return their results in arrays and store each object in it as array elements, you can take the first element you find out of the array and pass it to *Format-List*:

```
  $result = Get-Service
  $result[0] | Format-List *

    Name                : AeLookupSvc
    CanPauseAndContinue : False
    CanShutdown         : False
```

```
CanStop              : True
DisplayName          : Applicationlookup
DependentServices    : {}
MachineName          : .
ServiceName          : AeLookupSvc
ServicesDependedOn   : {}
ServiceHandle        :
Status               : Running
ServiceType          : Win32ShareProcess
Site                 :
Container            :
```

Now, you can already see all of the object's properties and then its current values. It should be obvious right away that the information sought can be found in the *Status* property, so you only want to view the objects whose *Status* property contains the "running" value. You're now ready to use the pipeline filter:

```
Get-Service | Where-Object { $_.Status -eq "Running" }

  Status   Name               DisplayName
  ------   ----               -----------
  Running  AeLookupSvc        Applicationlookup
  Running  AgereModemAudio    Agere Modem Call Progress Audio
  Running  Appinfo            Applicationinformation
  Running  AppMgmt            Applicationmanagement
  Running  Ati External Ev... Ati External Event Utility
  Running  AudioEndpointBu... Windows-Audio-Endpoint-building
  Running  Audiosrv           Windows-Audio
  Running  BFE                Basis Filter Engine
  Running  BITS               Intelligent Background Transmiss...
  (...)
```

In fact, it works just the way you want it to work so that now you can see only those services that are actually running. How does *Where-Object* function? The cmdlet expects you to type a PowerShell command in braces and evaluate the command for every pipeline object. The object that *Where-Object* was just examining can always be found in the variable *$_*. *$_.Status* returns the *Status* property content and needs only be compared to the value that you want to let through.

In reality, the instruction behind *Where-Object* works like a condition (see Chapter 7): if the expression results in *$true*, the object will be let through. That's why you may formulate conditions as complex as you like, but you must only make sure that your instruction results in either *$true* or *$false*.

The pipeline filter's principle may be applied to all object types and works in the same way everywhere. As an experienced administrator, you may be a little disappointed that the service objects returned by *Get-Service* contain relatively little information. If you want to list all services that would automatically start, but at the moment aren't running, you can leverage the built-in Windows Management Instrumentation (WMI) infrastructure as an information source to supply more data. You'll harvest much more information when you ask it about services:

```
$services = Get-WmiObject Win32_Service
$services[0] | Format-List *
```

```
Name                    : AeLookupSvc
Status                  : OK
ExitCode                : 0
DesktopInteract         : False
ErrorControl            : Normal
PathName                : C:\Windows\system32\svchost.exe -k netsvcs
ServiceType             : Share Process
StartMode               : Auto
__GENUS                 : 2
__CLASS                 : Win32_Service
__SUPERCLASS            : Win32_BaseService
__DYNASTY               : CIM_ManagedSystemElement
__RELPATH               : Win32_Service.Name="AeLookupSvc"
__PROPERTY_COUNT        : 25
__DERIVATION            : {Win32_BaseService, CIM_Service, CIM_Logic
                          alElement, CIM_ManagedSystemElement}
__SERVER                : TOBIASWELTNE-PC
__NAMESPACE             : root\cimv2
__PATH                  : \\TOBIASWELTNE-PC\root\cimv2:Win32_Service.
                          Name="AeLookupSvc"
AcceptPause             : False
AcceptStop              : True
Caption                 : Applicationlookup
CheckPoint              : 0
CreationClassName       : Win32_Service
Description             : Processes application compatibility cache
                          requirements when applications start.
DisplayName             : Applicationlookup
InstallDate             :
ProcessId               : 1276
ServiceSpecificExitCode : 0
Started                 : True
StartName               : localSystem
State                   : Running
SystemCreationClassName : Win32_ComputerSystem
SystemName              : TOBIASWELTNE-PC
TagId                   : 0
WaitHint                : 0
```

The information needed for your criteria are located in the *Started* and *StartMode* properties. And because the *Where-Object* pipeline filter is used very often, there exists a practical abbreviation for it: "?". Here is an example of what your pipeline filter could look like:

```
Get-WmiObject Win32_Service |
  ? {($_.Started -eq $false) -and ($_.StartMode -eq "Auto")} |
  Format-Table

  ExitCode Name           ProcessId StartMode State   Status
  -------- ----           --------- --------- -----   ------
         0 Automatic...           0 Auto      Stopped OK
         0 ehstart                0 Auto      Stopped OK
         0 LiveUpdate...          0 Auto      Stopped OK
         0 WinDefend         0 Auto     Stopped     OK
```

If everything works properly, these lines shouldn't report any services at all because services in the "auto" start-up mode are automatically started and, for this reason, should be running. If you're notified of services, you should verify whether these services are (no longer) running despite auto start. One cause could be that the service has completed its task and was then ended as scheduled.

Incidentally, because WMI objects are not on the internal PowerShell list, results are always displayed as lists. For this reason, at the end our above example, we set a table format using *Format-Table*, which is much clearer.

note

The internal WMI service will provide you with helpful information about your computer in response to almost any question. You'll find out exactly what it is in Chapter 18. If you use the *-query* parameter, you can pass SQL-type queries to this service so that the command will automatically return only the information sought and make pipeline filtering superfluous. You should always keep in mind when using any command that the pipeline filter is practical and easy to use, but not particularly economical. It limits results that are already available. It is better right at the beginning to ask only about the information needed, as it is not as easy to do for all commands as it is for *Get-WmiObject*:

```
Get-WmiObject -query "select * from win32_Service where `
  Started=false and StartMode='Auto'" | Format-Table


  ExitCode Name              ProcessId StartMode State   Status
  -------- ----              --------- --------- -----   ------
         0 Automatic Li...           0 Auto      Stopped OK
         0 ehstart                   0 Auto      Stopped OK
         0 LiveUpdate N...           0 Auto      Stopped OK
         0 WinDefend                 0 Auto      Stopped OK
```

Selecting Object Properties

The information contained in individual objects may be limited as well. You've just seen that some objects, depending on type, may contain many properties of which you often need only a few. By using *Select-Object*, you can select those properties that really interest you. All other properties will not be allowed through by *Select-Object*. For example, the following lines will acquire the user object for the integrated Guest account of your computer:

```
Get-WmiObject Win32_UserAccount -filter `
  "LocalAccount=True AND Name='guest'"

  AccountType : 512
  Caption     : TobiasWeltne-PC\guest
  Domain      : TobiasWeltne-PC
```

```
    SID          : S-1-5-21-3347592486-2700198336-2512522042-501
    FullName     :
    Name         : guest
```

Most of these properties won't interest you, so *Select-Object* was able to remove them. In the following, just three of your specified properties were returned:

```
  Get-WmiObject Win32_UserAccount -filter `
    "LocalAccount=True AND Name='guest'" |
    Select-Object Name, Disabled, Description

    Name   Disabled  Description
    ----   --------  -----------
    guest  True      Default account for guests...
```

You could have had the same result if you had used a formatting cmdlet. That would even have been to your advantage since you could use the *-autosize* parameter to optimize column width:

```
  Get-WmiObject Win32_UserAccount -filter `
    "LocalAccount=True AND Name='guest'" |
    Format-Table Name, Disabled, Description -autosize

    Name Disabled Description
    ---- -------- -----------
    guest    True Default account for guest access to computer or domain
```

The significant difference: *Format-Table* converts properties specified to the object into text. In contrast, *Select-Object* creates a completely new object containing just these specified properties:

```
  Get-WmiObject Win32_UserAccount -filter `
    "LocalAccount=True AND Name='guest'" |
    Select-Object Name, Disabled, Description |
    Format-Table *

    Name Disabled Description
    ---- -------- -----------
    guest    True Default account for guest access to computer or domain
```

tip

You should make sparing use of *Select-Object* because it takes a disproportionate effort to create a new object. Instead, use formatting cmdlets to specify which object properties are to be displayed. *Select-Object* is particularly useful when you don't want to convert a pipeline result into text, but instead want to output a comma-separated list using *Export-Csv* or HTML code using *ConvertTo-Html*.

If you type an asterisk as wildcard character after *Select-Object*, all properties will be marked as relevant. Formatting cmdlets will now output all object properties:

```
Dir | Select-Object * | Format-Table -wrap
```

If you'd like to view nearly all of an object's properties, it's easier to display only the properties you don't want by typing the parameter *-exclude* to specify those properties you want to remove from the object. The next line will output all of a file's properties and directory objects, except for those beginning with "PS" (and show internal PowerShell help properties):

```
Dir | Select-Object * -exclude PS*
```

Limiting Number of Objects

Select-Object filters not only object properties but can also, if you prefer, reduce the number of objects allowed to traverse the pipeline. This function is considerably more interesting because it allows you to view, among others, the five largest files of a directory or the five processes that have been running the longest:

```
# List the five largest files in a directory:
Dir | Sort-Object Length -descending |
  Select-Object -first 5
# List the five longest-running processes:
Get-Process | Sort-Object StartTime |
  Select-Object -last 5 | Format-Table ProcessName, StartTime
# Alias shortcuts make the line shorter but also harder to read:
gps | sort StartTime -ea SilentlyContinue |
  select -last 5 | ft ProcessName, StartTime

  ProcessName            StartTime
  -----------            ---------
  iexplore               20.09.2007 15:00:20
  iexplore               20.09.2007 15:05:26
  iexplore               20.09.2007 15:30:51
  PowerShellPlus.vshost  20.09.2007 16:07:54
  iexplore               20.09.2007 16:56:20
```

A couple of things are interesting here. For example, if you sort a list of processes by *StartTime*, you'll presumably get several error messages. If you aren't logged on with administrator privileges, you may not retrieve the information from some processes. However, you can avoid this difficulty by setting *Sort-Object* with parameter *-ErrorAction* (in short: *-ea*) to *SilentlyContinue*. This option is available for nearly every cmdlet and makes sure that error messages won't be displayed.

As a result of such restricted access, not all processes will have any control at all over *StartTime*. Wherever you can't read the start time because you don't have administrator privileges, a null value will be returned, which messes up the sorting result. You wouldn't get the right results if you wanted to use *-first* to view the processes that last started running,:

```
Get-Process | Sort-Object StartTime |
  Select-Object -first 5 |
  Format-Table ProcessName, StartTime

  ProcessName     StartTime
  -----------     ---------
```

```
    services
    SLsvc
    SearchIndexer
    opvapp
    sdclt
```

Sort-Object uses the value *0* for empty properties. That's why PowerShell gives you the processes for which it couldn't find any start times. This is interesting since those would be exactly the processes which you have no full access rights. However, this is a problem you can solve, and you already know how: by using the pipeline as just previously described. You should simply filter all of the pipeline's objects out that have an empty *StartTime* property so that you can better understand what those processes actually are, and then add the *Description* property in the output. That's where process objects record a brief description of the process:

```
  Get-Process | Where-Object {$_.StartTime -ne $null} |
    Sort-Object StartTime | Select-Object -first 5 |
    Format-Table ProcessName, StartTime, Description

    ProcessName   StartTime           Description
    -----------   ---------           -----------
    taskeng       19.09.2007 09:35:19 Task planning module
    dwm           19.09.2007 09:35:19 Desktop window manager
    explorer      19.09.2007 09:35:19 Windows Explorer
    GiljabiStart  19.09.2007 09:35:21 Giljabi Start
    ATSwpNav      19.09.2007 09:35:21 ATSwpNav Application
```

tip

If you concatenate several commands in the pipeline, you can use *Tee-Object* to skim off intermediate results: either because you need this information somewhere else, too, or because you want to check how the pipeline is working.

```
Get-Process | Tee-Object -variable a1 |
  Select-Object Name, Description |
  Tee-Object -variable a2 |
  Sort-Object Name
```

Get-Process first returns all running processes in this pipeline. *Select-Object* removes every object property except for *Name* and *Description*. It then sorts the processes by name. At two locations in this pipeline, *Tee-Object* accesses the current pipeline result and stores it in a variable without further slowing or influencing pipeline execution. After the pipeline has done its work, you'll find the intermediate result in the variables *$a1* and *$a2*, and you'll be able to analyze it in more depth or use it somewhere else.

If you decide not to set *Tee-Object* to the *-variable* parameter, the intermediate result will be saved to a file, and *Tee-Object* will expect you to provide a file path name. The same applies if you expressly specify the *-filePath* parameter.

Processing All Pipeline Results Simultaneously

If you prefer, you may also submit the results separately to the pipeline and then decide on a case-by-case basis what to do with them. The right tool is the *ForEach-Object* cmdlet that can convert objects into text:

```
Get-Service | ForEach-Object {
  "The service {0} is called '{1}': {2}" -f `
  $_.Name, $_.DisplayName, $_.Status }

  The service AeLookupSvc is called 'Application Lookup': Running
  The service AgereModemAudio is called 'Agere Modem Call Progress
  Audio': Running
  The service ALG is called 'Application Layer Gateway Service': Stopped
  The service Appinfo is called 'Application Information': Running
  The service AppMgmt is called 'Application Management': Stopped
  The service Ati External Event Utility is called 'Ati External Event
  Utility': Running
  The service AudioEndpointBuilder is called 'Windows-Audio-Endpoint-
  Generator': Running
  (...)
```

An instruction block in braces follows *ForEach-Object* so you can execute as many PowerShell commands as you like as long as you separate the commands by ";". This statement block is executed for every single pipeline object: within the block the current object is available in the $_ variable. In the example, *ForEach-Object* output a text for every service retrieved by *Get-Service* and inserts into the text the three properties *Name*, *DisplayName*, and *Status*.

In case you're asking yourself right now what "-f" is and how to insert information into text: look it up in Chapter 13, where all the tasks involving text are explained in detail.

ForEach-Object is actually just *Where-Object*'s big brother; *ForEach-Object*, *Where-Object*, can filter out pipeline objects by criterion. To enable *ForEach-Object* to do this, you merely use a condition. That is, only if the condition is met will the object you want be back in the pipeline. The following lines all lead to the same result:

```
Get-Service | Where-Object { $_.Status -eq "Running" }
Get-Service | ? { $_.Status -eq "Running" }
Get-Service | ForEach-Object { if ($_.Status -eq "Running") { $_ }
}
Get-Service | % { if ($_.Status -eq "Running") { $_ } }
```

All four lines retrieve a list of currently running services. You see that *Where-Object* can be shortened with "?" and *ForEach-Object* with "%". You also can see that *Where-Object* is actually only *ForEach-Object* with a built-in condition. For *Where-Object*, the condition is directly within the braces, and for *ForEach-Object* in parentheses after the *If* statement. The rationale for the existence of *Where-*

Object is comfort and clarity.

pro tip

ForEach-Object actually executes three script blocks, not just one. If you specify only one script block in braces after *ForEach-Object*, it will be executed once for every pipeline object. If you specify two script blocks, the first will be executed once and before the first pipeline object. If you specify three script blocks, the last will be executed once after the last pipeline object. The following will help you carry out initialization and tidying tasks or simply output initial and ending messages:

```
Get-Service | ForEach-Object {"Running services:"}{
  if ($_.Status -eq "Running") { $_ } }{"Done."}
```

The three script blocks of *ForEach-Object* actually correspond to the three script blocks *begin*, *process*, and *end*, which you'll examine in more detail in Chapters 9 and 12. You'll understand after reading these chapters that functions, cmdlets like *ForEach-Object* and script blocks, are all three basically the same.

Removing Doubles

Get-Unique removes duplicate entries from a sorted list as it presumes that the list was initially sorted according to criterion to make things easier. *Get-Unique* goes through every element on the list and compares it with the preceding ones. If two are identical, the new object is discarded. So, if you haven't done any sorting, *Get-Unique* won't work:

```
1,2,3,1,2,3,1,2,3 | Get-Unique

  1,2,3,1,2,3,1,2,3
```

Only after you sort the list—in this case, an array—will doubles be removed:

```
1,2,3,1,2,3,1,2,3 | Sort-Object | Get-Unique

  1,2,3
```

This method is particularly interesting when you break down text files' contents into single words. You can use the following line to do so:

```
$filename = "c:\autoexec.bat"
$(foreach ($line in Get-Content $filename) {
  $line.tolower().split(" ")})
```

Then, you could sort this list of each word of a file and then either send it to *Get-Unique* (the list of all words that are in a text) or to *Group-Object* (the number of words used in a text):

```
$filename = "c:\autoexec.bat"
$(foreach ($line in Get-Content $filename) {
  $line.tolower().split(" ")}) | Sort-Object | Get-Unique
$(foreach ($line in Get-Content $filename) {
  $line.tolower().split(" ")}) | Sort-Object | Group-Object
```

Analyzing and Comparing Results

Using the cmdlets *Measure-Object* and *Compare-Object*, you can measure and evaluate PowerShell command results. For example, *Measure-Object* allows you to determine how often particular object properties are distributed. *Compare-Object* enables you to compare before-and-after snapshots.

Statistical Calculations

Using the *Measure-Object* cmdlet, you can carry out statistical calculations so you can work out minimal, maximal, and average values for a particular object property. For example, if you want to know how files sizes are distributed in a directory, let *Dir* give you a directory listing and then examine the *Length* property:

```
Dir | Measure-Object Length

  Count    : 50
  Average  :
  Sum      :
  Maximum  :
  Minimum  :
  Property : Length
```

Measure-Object counts by default only the specified property's frequency. You should now know that there are 50 objects that have the *Length* property. Use the relevant parameters if you'd also like to receive the other statistical statements:

```
Dir | Measure-Object Length -average -maximum -minimum -sum

  Count    : 50
  Average  : 36771,76
  Sum      : 1838588
  Maximum  : 794050
  Minimum  : 0
  Property : Length
```

Measure-Object can also search through other text files and ascertain the frequency of characters, words, and lines in them:

```
Get-Content c:\autoexec.bat | Measure-Object -character -line -word
```

```
    Lines   Words   Characters Property
    -----   -----   ---------- --------
        1       5           24
```

Comparing Objects

You may often want to compare "before-and-after" conditions to find out which processes have restarted since a certain point in time, or which services have changed in comparison to a particular initial state. The *Compare-Object* cmdlet can perform this task by making use of the fact that PowerShell commands do not retrieve text internally, but real objects.

Comparing Before-and-After Conditions

For example, you should take a snapshot first if you want to find out whether new processes have started up, or running processes, have terminated in a certain period of time::

```
  $before = Get-Process
```

All processes will now be stored in the variable *$before*. To be exact, *$before* is an array in which every process is represented by a process object. You can now compare the current state at any time you like with this snapshot. Just pass the snapshot list and the list of currently running processes to *Compare-Object,*which will subsequently establish the differences between the two lists:

```
  Compare-Object -referenceObject $before `
    -differenceObject (Get-Process)

    InputObject                                     SideIndicator
    -----------                                      -------------
    System.Diagnostics.Process (regedit)             =>
    System.Diagnostics.Process (SearchFilterHost)    <=
    System.Diagnostics.Process (SearchProtocolHost)  <=
```

tip

If you're wondering right now why the current list of processes after *-differenceObject* is enclosed in parentheses, just remember that parameters expect actual results. In the example, the list of currently running processes is acquired as they are newly generated by the *Get-Process* cmdlet. This command must be placed between parentheses because *Get-Process* is a cmdlet and the list in question... Everything in parentheses will be executed by PowerShell first and the call result returned afterwards. *Compare-Object* can work with this result. If you had left out the parentheses, *-differenceObject* wouldn't have known what to do with the *Get-Process* specification.

Alternatively, you could, of course, have stored the list of current processes in a variable first, and then passed this variable, even without parentheses, to *Compare-Object*. It's not absolutely necessary to specify the parameter name if you state the arguments in the right order at the very beginning, that is, first the list with the "before" state, and then the list with the "after" state:

```
$after = Get-Process
Compare-Object $before $after
```

The *SideIndicator* column (line?) reports whether a new process has started running ("=>") or has been ended in the meantime ("<="). Consequently, *Compare-Object* returns only those processes that are different. Use *-includeEqual* as an additional parameter, if you want to see the processes that have not been changed. Use the additional parameter *-excludeDifferent*, if you'd like to see only those processes that have not been modified.

Detecting Changes to Objects

If you use *Compare-Object* as described above, it will only check whether every object in one list is matched in another list. While comparing them to their initial state, may be sufficient to determine whether objects were removed or added, you can't use this approach to establish whether an object's inner status has changed.

For example, if you'd like to verify whether services have stopped or started in comparison to their defined initial state, *Compare-Object* won't initially help you because when a service is stopped it still exists: only its inner status has changed. You should instead instruct *Compare-Object* to compare one or more of the object's properties by using *Format-List* to easily determine which properties are available to you. You should. first acquire a service object and experiment around with it a little:

```
# Pick out Windows Update Service:
$service = Get-Service wuauserv
# Inspect all properties of this services:
$service | Format-List *

  Name                : wuauserv
  CanPauseAndContinue : False
  CanShutdown         : True
  CanStop             : True
  DisplayName         : Windows Update
  DependentServices   : {}
  MachineName         : .
  ServiceName         : wuauserv
  ServicesDependedOn  : {rpcss}
  ServiceHandle       :
  Status              : Running
  ServiceType         : Win32ShareProcess
  Site                :
  Container           :
```

It quickly turns out that the *Status* property retrieves the desired information. So, you could first make another snapshot of all services, stop a service subsequently, and then instruct *Compare-Object* to use the *Status* property to ascertain differences:

```
# Save current state:
$before = Get-Service
# Pick out a service and stop this service:
# (Note: this usually requires administrator rights.
# Stop services only if you are sure that the service
# is absolutely not required.
$service = Get-Service wuauserv
$service.Stop()
# Record after state:
$after = Get-Service
# A simple comparison will not find differences because
# the service existed before and after:
Compare-Object $before $after
# A comparison of the Status property reports the halted
# service but not its name:
Compare-Object $before $after -Property Status

  Status   SideIndicator
  ------   -------------
  Stopped  =>
  Running  <=

# A comparison with the Status and Name properties returns
# the required information:
Compare-Object $before $after -Property Status, Name


  Status   Name      SideIndicator
  ------   ----      -------------
  Stopped  wuauserv  =>
  Running  wuauserv  <=
```

If you instruct *Compare-Object* with the parameter *-property* to compare the *Status* and *Name* properties, you'll receive the information you want: the service *wuauserv* was executed in the list in *$before*, but not in the list in *$after*. So it was stopped.

note

This example shows how to stop services. In the next chapter, you'll learn more about the methods (commands) built into objects. What's important to note here is only that you change the state of any service. You could also accomplish that by using the Microsoft Management Console Snapin for services:

```
services.msc
```

Start or stop only those services that you know won't incur any risk when you start or stop them. If an error message pops up when you try to modify a service, this is usually because you don't have administrator rights. Just remember that for Vista, or when group policies are in effect, that you must start up PowerShell with administrator rights. Otherwise, you're only a normal user, even if you log on with an administrator account.

Since the *Compare-Object* results consist of objects, you could make a further analysis of the result. Perhaps all that interests you are executed modifications. Use a pipeline filter, such as *Where-Object*, to specify to the filter that you're interested in only those objects in which the *SideIndicator* property corresponds to the value "=":

```
Compare-Object $before $after -property Status, Name |
  Where-Object { $_.SideIndicator -eq "=>" }

  Status   Name       SideIndicator
  ------   ----       -------------
  Stopped  wuauserv   =>
```

If you'd like to formulate the result in plain text, use a loop, such as, *Where-Object*, and use the information in the retrieved objects to put together the plain text:

```
Compare-Object $before $after -property Status, Name |
  Where-Object { $_.SideIndicator -eq "=>" } |
  ForEach-Object { "The service {0} has changed its status to {1}" `
    -f $_.Name, $_.Status}

  The service wuauserv has changed its status to Stopped
```

You can use this same procedure for widely varying monitoring tasks. Think in advance about which command you could use to determine an object's status to be monitored and, which of the object's properties will describe its status. For example, if you want to find out whether files in a directory have changed, the right command would be *Dir* and the property could be *Length* (because of the changed file size) or *LastWriteTime* (the contents could have been changed even if its size is just as large as it was before). Here's an example:

```
# Create test file and Before snapshot of the directory:
"Hello" > test.txt
$before = Dir
# Modify test file and create After snapshot of the directory:
"Hello world" > test.txt
$after = Dir
# Compare-Object reports all files whose size has changed:
Compare-Object $before $after -property Length, Name

  Length  Name       SideIndicator
  ------  ----       -------------
      26  test.txt   =>
      16  test.txt   <=

# Files whose size is unchanged, however, were not recognized
# although they were changed:
"Hey!" > test.txt
$after = Dir
Compare-Object $before $after -property Length, Name
# So, when comparing, it is crucial to select a meaningful
# property, e.g., LastWriteTime:
Compare-Object $before $after -property Length, LastWriteTime, Name


  Length  LastWriteTime        Name      SideIndicator
  ------  -------------        ----      -------------
      16  20.09.2007 14:13:09  test.txt  =>
      16  20.09.2007 14:13:02  test.txt  <=
```

Comparing File Contents

A special form of the "snapshot" is a file's text contents. If you read text contents using *Get-Content*, you'll get an array with lines of text. *Compare-Object* can compare this array again and determine which lines within text files have changed: Here's another example:

```
# Create first test file:
@"
>> Hello
>> world
>> "@ > test1.txt
>>
# Create second test file:
@"
>> Hello
>> beautiful
>> world
>> "@ > test2.txt
>>
# Compare both files and show only differing lines:
Compare-Object -referenceObject $(Get-Content test1.txt) `
  -differenceObject $(Get-Content test2.txt)

  InputObject  SideIndicator
  -----------  -------------
  beautiful    =>

Compare-Object -referenceObject $(Get-Content test1.txt) `
  -differenceObject $(Get-Content test2.txt) -includeEqual

  InputObject  SideIndicator
  -----------  -------------
  Hello        ==
  world        ==
  beautiful    =>
```

Saving Snapshots for Later Use

Some before-and-after comparisons may not be able to be completed in one day. Perhaps you would like to compare operating states over a longer time period, and are not sure if the computer (and your PowerShell) is running the entire time without interruptions. Or maybe you would like to use the same precisely set initial state. In this case, you can "serialize" the objects in the initial state. In other words, the objects are stored as a file in a special data format, more or less "frozen." Later, you can load the object at any time from the file and use them for comparison.

The *Export-Clixml* cmdlet carries out serialization. All you need to do is to specify a file name under which the objects can be saved. For example, the following line saves a list of all running processes to the file *before.xml*:

```
Get-Process | Export-Clixml before.xml
```

Because the initial state is now stored as a file, you could close PowerShell and reboot your computer. As soon as you are ready to compare the current processes with the stored initial status, you can load the file back in PowerShell:

```
$before = Import-Clixml before.xml
```

However, if you try to compare the contents of *$before* with the current list of processes, *Compare-Object* will output an endless list of deviations:

```
$after = Get-Process
Compare-Object $before $after
```

In the simplest scenario, *Compare-Object* only verifies whether the objects are in both lists. But as soon as you serialize or "freeze" objects, your object type changes. If you use *Import-Clixml* later to input these objects, the information will be brought back to life in a different type while the objects will continue to contain all information. Why? Because the re-input objects no longer correspond to running processes but are the "unfrozen" older processes.

You already know the solution to the problem: simply instruct *Compare-Object* to compare particular properties because the revived objects continue to contain all the important information. As soon as you compare objects, *Compare-Object* doesn't care at all about the object type as long as the objects to be compared support the same properties:

```
Compare-Object $before $after -property Name

  Name     SideIndicator
  ----     -------------
  notepad  =>
  regedit  <=
```

You now know that a process called *notepad* has been added since the snapshot and a process called *regedit* was ended. However, you wouldn't yet know whether the processes that have the same name are in fact identical. To find out, you would have to include additional object properties in the comparison, such as the process ID, which clearly identifies processes:

```
Compare-Object $basis (Get-Process) -property Id, Name
```

```
    Id     Name                     SideIndicator
    --     ----                     -------------

    7788   notepad                  =>
    8004   PowerShellPlus.vshost    =>
    3032   PowerShellPlus.vshost    <=
     344   regedit                  <=
```

Now, you can see as well that PowerShell was started up again once. The instance of PowerShell with the process ID *8004* was ended and in its place a new instance of PowerShell with the process ID *3032* was started.

Exporting Pipeline Results

You have learned that pipeline results are converted into text when they reach the pipeline's end at the latest and are output in the console because PowerShell appends the *Out-Default* cmdlet to the end of every entry. As a result, this cmdlet decided where pipeline results will be output. Along with *Out-Default*, there are a number of additional output cmdlets that you can put at your pipeline's end so the result is redirected to a file or printed out rather than output in the console. The pipeline stops its work on reaching the first output cmdlet; if you enter one, *Out-Host*, which PowerShell appends automatically, won't go into operation:

```
  Get-Command -verb out

    CommandType   Name          Definition
    -----------   ----          ----------
    Cmdlet        Out-Default   Out-Default [-InputObject <PSObject>]...
    Cmdlet        Out-File      Out-File [-FilePath] <String> [[-Enco...
    Cmdlet        Out-Host      Out-Host [-Paging] [-InputObject <PSO...
    Cmdlet        Out-Null      Out-Null [-InputObject <PSObject>] [-...
    Cmdlet        Out-Printer   Out-Printer [[-Name] <String>] [-Inpu...
    Cmdlet        Out-String    Out-String [-Stream] [-Width <Int32>]...

  Dir | Out-File output.txt
  .\output.txt
  Dir | Out-Printer
```

tip

Out-File supports the parameter *-encoding*, which you can use to determine the format in which information is written to a file. If you don't remember which encoding formats are allowed, just specify a value which you know is absolutely false, and then the error message will tell you which values are allowed:

```
Dir | Out-File -encoding Dunno

  Out-File : Cannot validate argument "Dunno" because it does
  not
  belong to the set "unicode, utf7, utf8, utf32, ascii,
  bigendianunicode, default, oem".
```

```
    At line:1 char:25
    + Dir | Out-File -encoding  <<<< Dunno
```

An alternative to *Out-File* is *Export-Csv*. You can specify comma-separated lists with this cmdlet. You'll read more about that a little later on.

Suppressing Results

Send the output to *Out-Null* if you want to suppress command output:

```
# This command not only creates a new directory but also returns
# the new directory:
md testdirectory

  Directory: Microsoft.PowerShell.Core\FileSystem::C:\Users\
  Tobias Weltner
  Mode   LastWriteTime      Length Name
  ----   -------------      ------ ----
  d----  19.09.2007 14:31          testdirectory

rm testdirectory
# Here the command output is sent to "nothing"
md testdirectory | Out-Null
rm testdirectory
# That matches the following redirection:
md testdirectory > $null
rm testdirectory
```

Changing Pipeline Formatting

At first glance, *Out-Host* seems somewhat superfluous since all results will end up in the console when you don't specify any output cmdlet. So what's the use of *Out-Host*? On the one hand, this cmdlet supports optional parameters like *-paging*, which can be used to output information page by page. You already tried that at the beginning of this chapter. In addition, you can use *Out-Host* to control pipeline formatting, which in itself is much more important.

The reason is that all output cmdlets not only output all pipeline results to the relevant output device, but also automatically convert pipeline objects into readable text. You've already learned how this conversion works by formatting cmdlets like *Format-Table*. This gets interesting when you specify neither a formatting nor an output cmdlet in your pipeline. Then, PowerShell takes action automatically, though sometimes the result can be confusing.

For example, can you explain why the next instruction outputs all services in table form, but the following in list form?

```
# Outputs services in table form:
```

```
Get-Service
# Outputs services in list form:
Get-Location; Get-Service
```

In the second line, the results of two commands are mixed. That's permitted, and you just have to remember to separate individual commands by a semicolon. None of the two commands outputs its results by using an output cmdlet. That's why all results remain in the pipeline and are automatically processed at the end by *Out-Host*. That's exactly what causes the problem since PowerShell extends the line in the following way behind the scenes:

```
& {Get-Location; Get-Service} | Out-Default
```

Out-Default determines whether you gave one of the formatting cmdlets a particular format. If not, it tries to find an appropriate format. In doing so, it takes a cue from the first object in the result, the path name of *Get-Location*. However, an unexpectedly colorful series of *Get-Service* services follows so no predefined format exists with which this muddled medley can be displayed, *Out-Default* falls back on the list format. You can encounter the problem described here in many places. It also affects, among others, functions or scripts:

```
# Example of problem when using a function:
function test {
 Get-Location
 Get-Service
}
test
# Example of problem when using a script:
@"
Get-Location
Get-Service
"@ > test.ps1
.\test.ps1
```

The solution to this problem: either specify a format for the pipeline yourself or send the results of individual commands to the console:

```
# Specify the output format yourself so that PowerShell won't need
# to specify the format:
Get-Location | Format-Table; Get-Service
# Or send the intermediate results to the console so that no mixed
# results appear:
Get-Location | Out-Host; Get-Service
```

Forcing Text Display

PowerShell delays conversion until the last possible moment and converts pipeline objects into text only until they reach the end of the pipeline since information is typically lost when objects are converted into text. However, by using *Out-String*, you can force PowerShell to convert objects into text any time you like. *Out-String* is the only output cmdlet that continues the pipeline instead of terminating it. *Out-String* puts the objects it receives back into the pipeline as text. You can assign the result to a variable Because it behaves like a normal pipeline command.:

```
$text = Dir | Out-String
$text.toUpper()
```

The result of *Out-String* is always a single, complete text. That also means that *Out-String* blocks the pipeline stream and waits until all results arrive. If you'd prefer getting the text line by line in an array, use the *-stream* parameter; then *Out-String* will transform incoming objects into single blocks of text in real time and won't block the pipeline:

```
Dir | Out-String -stream | ForEach-Object { $_.toUpper() }
```

note

If possible, you should avoid turning objects into text because that makes them lose the structure and many options that only original objects offer.

Excel: Exporting Objects

All output cmdlets convert pipeline results into text that may be displayed haphazardly. An alternative are comma-separated lists generated by *Export-Csv*. Comma-Separated Value (CSV) files that can then be opened in programs like Microsoft Excel allows you to continue working smoothly with the data retrieved by PowerShell. You can then turn columns of numbers into expressive graphics.

```
Dir | Export-Csv test.csv
.\test.csv
```

The objects returned by *Dir* are converted into text along with all their properties. Open the resulting CSV file and, if you have installed Microsoft Excel, the information will be displayed column-by-column as an Excel spreadsheet. You could also display the information in a text editor if you don't have Excel.

tip

While Excel can open a CSV file, but cannot identify the columns correctly, the fault may lie with your country settings. *Export-CSV* uses as default separator the list separator "," that is internationally customary. For example, if you're using a German system, the Windows control panel country settings would use the not very customary tab character as list separator. So that Excel can import comma-separated lists correctly, you must change either the list separator character in your regional settings or change the separator character from a comma to a tab in the resulting CSV file:

```
# Make a comma-separated list
Dir | Export-Csv test1.csv
# Replace a comma by a tab respectively in this list
Get-Content test1.csv | ForEach-Object { $_.replace(',', "`t") }
|
  Out-File test2.csv
```

```
# A German system will now assign columns correctly in Excel:
.\test2.csv
```

However, this is a case of a very simple replacement so it doesn't take into consideration the commas that could be found in column text.

Export-Csv consequently takes care of the formatting data job by writing all object properties as arrays in comma-separated files. What happens when you mess things up by using a formatting cmdlet is shown by the next example:

```
Dir | Format-Table | Export-Csv test.csv
.\test.csv
```

The information in the CSV file is now nearly unreadable, and it becomes clear how formatting cmdlets do their work behind the scenes by embedding objects in their own formatting instructions. That's why you may never use formatting cmdlets if you want to use *Export-Csv* to store raw information in a file. In general, you should also use formatting cmdlets only at the end of your pipeline so that formatting instructions will not disrupt other commands.

A question remains: if you use formatting cmdlets to specify which of an object's properties you're interested in, how then can you determine which properties are written into the CSV file? The answer is to strip away the unwanted properties from the objects by using *Select-Object*. You can then state the property that you want to keep. All the others will be removed from the object. That's the solution, for *Export-Csv* always writes all (remaining) properties into the CSV file:

```
Dir | Select-Object Name, Length, LastWriteTime | Export-Csv test.csv
.\test.csv
```

HTML Outputs

If you'd like, PowerShell can also pack its results into (rudimentary) HTML files. Converting objects into HTML formats is done by *ConvertTo-Html*:

```
Get-Process | ConvertTo-Html | Out-File output.htm
.\output.htm
```

But don't be alarmed if the procedure takes a while because PowerShell has to read out all of the objects' properties and save them as a HTML table. If you want to see only particular properties as a HTML report, as in the case of *Export-Csv*, you should never use formatting cmdlets. It would be better for you to use *Select-Object* here. You could also take this opportunity to give the HTML page a title by using the *-title* parameter. The title will turn up later on the title bar of the browser that is displaying your file. Unfortunately, the cmdlet doesn't have formatting options that go beyond this:

```
Get-Process | Select-Object Name, Description |
  ConvertTo-Html -title "Process Report" |
  Out-File output.htm
.\output.htm
```

The Extended Type System (Part One)

One of the PowerShell console's most remarkable capabilities is converting any object into text. You have seen how different formatting cmdlets can turn object properties into text and output them as text either beside or below each other.

What is striking in this connection is above all that PowerShell succeeds in only converting an object's essential properties into text. PowerShell would have to fail right from the beginning if it had to convert absolutely all of an object's properties into text, for then even a simple directory listing would generate a confusing amount of information:

```
Dir | Format-Table * -wrap

  PSPat PSPar PSChi PSDri PSPro PSIsC Mode   Name  Paren Exist Root   Full
  h     entPa ldNam ve    vider ontai              t         s        Name
        th    e                   ner



  ----- ----- ----- ----- ----- ----- ----   ----  ----- ----- ----   ----
  Micro Micro Appli C     Micro   True d---- Appli Tobia   True C:\   C:\U
  soft. soft. catio       soft.              catio s Wel              sers
  Power Power n Dat       Power              n Dat tner               \Tob
  Shell Shell a           Shell              a                        ias
  .Core .Core             .Core                                       Welt
  \File \File             \File                                       ner\
  Syste Syste             Syste                                       Appl
  m::C: m::C:             m                                           icat
  \User \User                                                         ion
  s\Tob s\Tob                                                         Data
  ias W ias W
  eltne eltne
  r\App r
  licit
  ion D
  ata
  Micro Micro Backu C     Micro   True d---- Backu Tobia   True C:\   C:\U
  soft. soft. p           soft.              p     s Wel              sers
  Power Power             Power                    tner               \Tob
  Shell Shell             Shell                                       ias
  .Core .Core             .Core                                       Welt
  \File \File             \File                                       ner\
  Syste Syste             Syste                                       Back
  m::C: m::C:             m                                           up
  \User \User
  s\Tob s\Tob
  ias W ias W
  eltne eltne
  r\Bac r
  kup
  (...)
```

You don't have to make do with this raw, completely unserviceable text conversion of object properties. You can convert text in a way that makes sense in a practical way by using the Extended Type System (ETS),. Only the ETS can enable PowerShell to process internal objects, waiting until they reach the end of the pipeline before transforming them into understandable text.

```
Dir

  Directory: Microsoft.PowerShell.Core\FileSystem::C:\Users\
  Tobias Weltner
  Mode                LastWriteTime     Length Name
  ----                -------------     ------- ----
  d----         01.10.2007     16:09           Application Data
  d----         26.07.2007     11:03           Backup
  (...)
```

The ETS consists of two parts. One part takes care of formatting objects and will be described next. The other part attends to object properties and will be explained in the next chapter.

Rendering Text as Text and Only Text

The ETS goes into action only when objects are output in the console. The ETS does nothing if the data is already available as text. So, if you wanted to use *Out-String* to convert a directory listing into text right from the beginning and then pass it through one of the formatting cmdlets, it would not be rendered any differently:

```
# Convert directory listing objects into plain text:
$text = Dir | Out-String
# All additional outputs will return the identical result,
# for text will not be converted:
$text
$text | Format-Table
$text | Format-List
```

Your Wish Has Priority

The ETS will still remain inactive if you specify after a formatting cmdlet like *Format-Table* which properties should be converted into text., The conversion of objects into text is not the problem, but the selection and differentiation of important and unimportant properties is the issue. If you specify which properties should be converted, you won't let the ETS make this decision:

```
# If you specify the properties, ETS will no longer select them:
Dir | Format-Table Name, Length, LastWriteTime
```

Known Objects and Formatting

If you use a formatting cmdlet like *Format-Table* without selecting properties after it, the ETS will go into action for the first time, because the way in which these objects are to be displayed and which properties are to be shown now must be selected automatically. To do this, the ETS first determines what kinds of objects are to be converted into text:

```
Dir | ForEach-Object { $_.GetType().FullName }
```

Dir returns files in a *System.IO.FileInfo* object and files in a *System.IO.DirectoryInfo* object. Then, the ETS looks in its own internal records to see how these objects must be converted into text. The records are stored in the form of XML files that have the file extension ".ps1xml":

```
Dir $pshome\*.format.ps1xml

  Mode          LastWriteTime    Length  Name
  ----          -------------    ------  ----
  -a---    13.04.2007 19:40     22120  Certificate.format.ps1xml
  -a---    13.04.2007 19:40     60703  DotNetTypes.format.ps1xml
  -a---    13.04.2007 19:40     19730  FileSystem.format.ps1xml
  -a---    13.04.2007 19:40    250197  Help.format.ps1xml
  -a---    13.04.2007 19:40     65283  PowerShellCore.format.ps1xml
  -a---    13.04.2007 19:40     13394  PowerShellTrace.format.ps1xml
  -a---    13.04.2007 19:40     13540  Registry.format.ps1xml
```

Every object is precisely defined in these XML files. Among others, the definition includes which object properties are supposed to be converted into text and whether the object should be displayed in the form of a list or table.

note

The ETS runs into trouble only when you mix several object types that don't really fit together, as is the case here:

```
Get-Process; Dir | Format-Table
```

```
(...)
out-lineoutput : Object of type
"Microsoft.PowerShell.Commands.
Internal.Format.FormatStartData" is not legal or not in the
correct sequence. This is likely caused by a user-specified
"format-table" command which is conflicting with the default
formatting.
```

The files and directories that *Dir* outputs cannot be displayed by the formatting that PowerShell uses for *Processes*. So, they won't allow themselves to be mixed. One solution would be to send the objects individually to the fitting formatter:

```
Get-Process | Format-Table; Dir | Format-Table
```

Another solution would be not to use any formatting cmdlets at all, because then the ETS would nose around automatically until it found the fitting format—as you will see soon.

Unknown Objects

If the object that the ETS is supposed to convert into text is unknown because it isn't defined in one of the ps1xml records, the ETS will flatly convert all properties of the object into text. Then, the question becomes whether the object is to be displayed as a table or a list. If there are fewer than five, the ETS uses a table view, otherwise a list view. You can verify that easily enough yourself by fabricating your own "homemade" objects:

```
# Create a new empty object:
$object = New-Object PSObject
# Attach a new property:
Add-Member NoteProperty "a" 1 -inputObject $object
# Powershell outputs the object with Format-Table and show the
# single property:
$object

  a
  -
  1

# Add three additional properties:
Add-Member NoteProperty "b" 1 -inputObject $object
Add-Member NoteProperty "c" 1 -inputObject $object
Add-Member NoteProperty "d" 1 -inputObject $object
# The object is still shown as a table:
$object

  a  b  c  d
  -  -  -  -
  1  1  1  1

# The fifth property makes a difference:
Add-Member NoteProperty "e" 1 -inputObject $object
# Now the object is converted with Format-List (properties below
# and not beside each other):
$object

  a : 1
  b : 1
  c : 1
  d : 1
  e : 1
```

Emergency Mode

If during output the ETS discovers a critical condition, it will automatically switch over to list view. Such a critical condition can arise, for example, when the ETS encounters unexpected objects. The following instruction will initially output the list of running processes in table view, but because file system objects turn up suddenly and unexpectedly, during the output the ETS switches over to emergency mode and lines up the remaining objects in list view.

```
Get-Process; Dir
```

"The Case of the Vanished Column"

When encountering unknown objects, the ETS always takes its cue from the first object that it outputs. That can cause a strange phenomenon. The ETS always shows all object properties for an unknown object, but only all object properties of the *first* object that the ETS outputs. If further objects follow with more properties, the present selection of properties remains and information is suppressed.

The following example shows how information can be withheld: *Get-Process* returns a list of running processes. They are sorted by the property *StartTime* and subsequently the only properties that are output are N*ame* and *StartTime*:

```
Get-Process | Sort-Object StartTime | Select-Object Name,StartTime
```

When you execute these lines, you may possibly get a lot of error messages, but that's not your fault. Without administrator privileges, you aren't allowed to access many processes: you can't even ask what the start-up time was. As a result, you'll get a list of processes of which only a few are listed with their start times. Only the process names are output. The start times of all processes is simply suppressed. Why?

Whenever you use *Select-Object* to take a property away from an object, you change the object type. *Get-Process* retrieves *Process* objects, and you cannot simply cancel the properties of these objects. That's why *Select-Object* wraps the information of the incoming *Process* objects in new objects, which it creates new:

```
Get-Process | Sort-Object StartTime |
  Select-Object Name,StartTime |
  ForEach-Object { $_.GetType().FullName }

  System.Management.Automation.PSCustomObject
  (...)
```

The new objects are of the *PSCustomObject* type. There is no entry in the ETS record for this object type, and so the ETS outputs all the properties of the *first* object. Because you had used *Sort-Object* to sort the output by ascending start times, the list begins with the objects that have no start time because of access restrictions.

As a result, the ETS recognizes only one property, *Name*, in the first object. It doesn't find the start time in the first object and so start times are not output for the following objects. You can solve this problem by not relying on the ETS, but instead selecting the object you want:

```
Get-Process | Sort-Object StartTime |
  Select-Object Name,StartTime |
  Format-Table Name, StartTime
```

ETS Enhancement

If the ETS is familiar with a certain object type, it can convert it into text optimally. For unknown objects, conversion is far less elegant, possibly even useless. Fortunately, the ETS can be enhanced: all you need to do is to teach ETS how to handle new object types so that they, too, can be displayed as text optimally.

Planning Enhancement

The first step of ETS enhancement is to determine which object type you want to display better. You may frequently use *Get-WmiObject* to get information from the WMI service, but you're not happy with the way PowerShell displays these objects:

```
Get-WmiObject Win32_Processor

  __GENUS                     : 2
  __CLASS                     : Win32_Processor
  __SUPERCLASS                : CIM_Processor
  __DYNASTY                   : CIM_ManagedSystemElement
  __RELPATH                   : Win32_Processor.DeviceID="CPU0"
  __PROPERTY_COUNT            : 48
  __DERIVATION                : {CIM_Processor, CIM_LogicalDevice,
                                CIM_LogicalElement, CIM_Managed
                                SystemElement}
  __SERVER                    : TOBIASWELTNE-PC
  __NAMESPACE                 : root\cimv2
  __PATH                      : \\TOBIASWELTNE-PC\root\cimv2:Win32_
                                Processor.DeviceID="CPU0"
  AddressWidth                : 32
  Architecture                : 9
  Availability                : 3
  Caption                     : x64 Family 6 Model 15 Stepping 6
  ConfigManagerErrorCode      :
  ConfigManagerUserConfig     :
  CpuStatus                   : 1
  CreationClassName           : Win32_Processor
  CurrentClockSpeed           : 1000
  CurrentVoltage              : 12
  DataWidth                   : 64
  Description                 : x64 Family 6 Model 15 Stepping 6
  DeviceID                    : CPU0
  ErrorCleared                :
  ErrorDescription            :
  ExtClock                    :
  Family                      : 1
```

```
    InstallDate                 :
    L2CacheSize                 : 4096
    L2CacheSpeed                :
    L3CacheSize                 : 0
    L3CacheSpeed                : 0
    LastErrorCode               :
    Level                       : 6
    LoadPercentage              :
    Manufacturer                : GenuineIntel
    MaxClockSpeed               : 2167
    Name                        : Intel(R) Core(TM)2 CPU T7400 @ 2.16GHz
    NumberOfCores               : 2
    NumberOfLogicalProcessors   : 2
    OtherFamilyDescription      :
    PNPDeviceID                 :
    PowerManagementCapabilities :
    PowerManagementSupported    : False
    ProcessorId                 : BFEBFBFF000006F6
    ProcessorType               : 3
    Revision                    : 3846
    Role                        : CPU
    SocketDesignation           : U1
    Status                      : OK
    StatusInfo                  : 3
    Stepping                    : 6
    SystemCreationClassName     : Win32_ComputerSystem
    SystemName                  : TOBIASWELTNE-PC
    UniqueId                    :
    UpgradeMethod               : 8
    Version                     : Modell 15, Stepping 6
    VoltageCaps                 :
```

First, find out what type of object is returned by the command:

```
  $object = Get-WmiObject Win32_Processor | Select-Object -first 1
  $object.GetType().FullName

    System.Management.ManagementObject
```

This shows you that you need an ETS enhancement for objects of the type *System.Management.ManagementObject*. Next, take a look at this object's properties and select one that you want the ETS to convert into text. For example, *DeviceID*, *Name*, and *ProcessorID*. Then, formulate the definition of the object in XML. In the *TableHeaders* area, set column headers, and in the *TableRowEntries* area, set object properties.

```
    <Configuration>
      <ViewDefinitions>
        <View>
          <Name>CustomView</Name>
          <ViewSelectedBy>
            <TypeName>System.Management.ManagementObject</TypeName>
          </ViewSelectedBy>
          <TableControl>
            <TableHeaders>
              <TableColumnHeader>
                <Label>Name</Label>
                <Width>12</Width>
              </TableColumnHeader>
              <TableColumnHeader>
                <Label>Description</Label>
                <Width>30</Width>
              </TableColumnHeader>
              <TableColumnHeader>
                <Label>ID</Label>
              </TableColumnHeader>
            </TableHeaders>
            <TableRowEntries>
              <TableRowEntry>
                <TableColumnItems>
                  <TableColumnItem>
                    <PropertyName>DeviceID</PropertyName>
                  </TableColumnItem>
                  <TableColumnItem>
                    <PropertyName>Description</PropertyName>
                  </TableColumnItem>
                  <TableColumnItem>
                    <PropertyName>ProcessorID</PropertyName>
                  </TableColumnItem>
                </TableColumnItems>
              </TableRowEntry>
            </TableRowEntries>
          </TableControl>
        </View>
      </ViewDefinitions>
    </Configuration>
```

Store this XML code in a file called *Win32_Processor.format.ps1xml.*Thhen, use *Update-FormatData* to read it into the ETS:

```
Update-FormatData Win32_Processor.format.ps1xml
```

Now, the result will be much easier to understand when you output *Win32_Processor*objects again:

```
Get-WmiObject Win32_Processor

  Name  Description                   ID
  ----  -----------                   --
  CPU0  x64 Family 6 Model 15 Stepp... BFEBFBFF000006F6
```

However, in this particular instance a mishap occurred. When you acquire other WMI objects, these will now also be displayed in the format that you just defined:

```
Get-WmiObject Win32_Share
```

```
Name  Description    ID
----  -----------    --
      Remote Admin
      Default share
      Default share
      Remote IPC
      Default share
```

The reason has to do with special features of the WMI. It returns *all* WMI objects in a *System.Management.ManagementObject* type.

```
$object = Get-WmiObject Win32_Service | Select-Object -first 1
$object.GetType().FullName

  System.Management.ManagementObject
```

So, the ETS didn't make a mistake. Instead, the culprit is the WMI as for WMI objects (and only for these), ETS enhancements must be more specific since the type name alone is not enough. That's why WMI objects are assigned to additional object types that you can find in the *PSTypeNames* property:

```
$object = Get-WmiObject Win32_Processor | Select-Object -first 1
$object.PSTypeNames

  System.Management.ManagementObject#root\cimv2\Win32_Processor
  System.Management.ManagementObject
  System.Management.ManagementBaseObject
  System.ComponentModel.Component
  System.MarshalByRefObject
  System.Object
```

The object name that is specific to *Win32_Processor* objects is called System.Management.ManagementObject*#root\cimv2\Win32_Processor*. So, you would have to specify this object name in your ETS enhancement so that the enhancement applies only to *Win32_Processor* WMI objects:

```
<Configuration>
  <ViewDefinitions>
    <View>
      <Name>CustomView</Name>
      <ViewSelectedBy>
        <TypeName>System.Management.ManagementObject#root
                  \cimv2\Win32_Processor</TypeName>
      </ViewSelectedBy>
      <TableControl>
        <TableHeaders>
          <TableColumnHeader>
(...)
```

Modify your enhancement accordingly, and read it again with *Update-FormatData*. You can safely ignore the resulting error message. After updating, your enhancement will be valid only for *Win32_Process* WMI objects.

Summary

PowerShell uses a pipeline for all command entries, which feeds the results of the preceding command directly into the subsequent command. The pipeline is active even when you enter only a single command because PowerShell always automatically adds the *Out-Default* cmdlet at the pipeline's end so that it always results in a two-member instruction chain.

Single command results are passed as objects. The cmdlets shown in Table 5.1 can filter, sort, compare, measure, expand, and restrict pipeline elements. All cmdlets accomplish this on the basis of object properties. In the process, the pipeline distinguishes between sequential and streaming modes. In streaming mode, command results are each collected, and then passed in mass onto the next command. Which mode you use depends solely on the pipeline commands used. Output cmdlets dispose of output. If you specify none, PowerShell automatically uses *Out-Host* to output the results in the console. However, you could just as well send results to a file or printer.

All output cmdlets convert objects into readable text while formatting cmdlets are responsible for conversion. Normally, formatting cmdlets convert only the most important, but if requested, all objects into text. The Extended Type System (ETS) helps convert objects into text. The ETS uses internal records that specify the best way of converting a particular object type into text. If an object type isn't in an ETS internal record, the ETS resorts to a heuristic method, which is guided by, among other things, how many properties are contained in the unknown object.

In addition to traditional output cmdlets, export cmdlets store objects either as comma-separated lists that can be opened in Excel or serialized in an XML format. Serialized objects can be comfortably converted back into objects at a later time. Because when exporting, in contrast to outputting, only plain object properties, without cosmetic formatting, are stored so that no formatting cmdlets are used.

CHAPTER 6.

Using Objects

PowerShell always works with objects. Whenever you output objects into the PowerShell console, PowerShell automatically converts the rich objects into readable text. In this chapter, you will learn what objects are and how to get your hands on PowerShell objects before they get converted to simple text.

Topics Covered:

Objects = Properties + Methods

In real life, you probably already know what an object is: everything you can touch. Objects in PowerShell are actually quite similar. Let's turn a typical real-world object like a pocketknife into a PowerShell object.

How would you describe this object to someone, let's say over a phone line? You would probably carefully examine the object and then describe what it *is* and what it *can* do:

- **Properties:** a pocketknife has particular properties, such as its color, manufacturer, size, or number of blades. The object *is* red, weights 55 grams, has three blades, and is made by the firm Idera. So *properties* describe what an object *is*.
- **Methods:** in addition, you can do things with this object, such as cut, turn screws, or pull corks out of wine bottles. The object *can* cut, screw, and remove corks. Everything that an object *can* is called its *methods*.

In the computing world, an object is very similar: its nature is described by properties, and the actions it can perform are called its methods. Properties and methods are called *members*.

Creating a New Object

Let's turn our real-life pocketknife into a virtual pocketknife. Using *New-Object*, PowerShell can generate new objects, even a virtual pocketknife. First you need a new and empty object:

```
$pocketknife = New-Object Object
```

This new object is actually pretty useless right now. If you call it, PowerShell will literally return "nothing":

```
$pocketknife
```

Adding Properties

Next, let's start describing what our object *is*. To do that, add properties to the object.

```
# Adding a new property:
Add-Member -memberType NoteProperty -name Color -value Red -inputObject
$pocketknife
```

Use the *Add-Member* cmdlet to add properties. Here, you added the property *Color* with the value *Red* to the object *$pocketknife*. If you call the object now, it suddenly has a first property telling the world that its color is red:

```
$pocketknife

  Color
  -----
  Red
```

In the same way, you now add more properties to describe the object even better. Remember that you don't need to completely write out parameter names. It is enough to write only as much as to make the parameter name unambiguous:

```
# Shorten parameter names:
Add-Member -Me NoteProperty -In $pocketknife -Na Weight -Value 55
```

In fact, you don't need to specify parameter names for some of the parameters at all because some of them are positional: provided you specify parameters in the right order, PowerShell can automatically assign your values to the correct parameter. Adding new properties to your object becomes even easier:

```
# Specify arguments without parameter names by position data:
Add-Member -inputObject $pocketknife NoteProperty Manufacturer Idera
```

Most PowerShell cmdlets can receive their input objects either by parameter (-inputObject) or via the pipeline, so you can add properties to your object in yet another way:

```
# Specify "inputObject" through the pipeline:
$pocketknife | Add-Member NoteProperty Blades 3
```

By now, you've described the object in *$pocketknife* with a total of four properties. If you output the object in *$pocketknife* in the PowerShell console, PowerShell automatically converts the object into readable text:

```
# Show all properties of the object all at once:
$pocketknife

  Color       Weight       Manufacturer       Blades
  -----       ------       ------------       -------
  Red         55           Idera              3
```

Outputting an object to the console gets you a quick overview over its properties. To access the value of a specific property, add a dot and then the property name:

```
# Display a particular property:
$pocketknife.manufacturer

  Idera
```

Adding Methods

With every new property you added to your object, *$pocketknife* has been gradually taking shape, but it still really can't *do* anything. Properties only describe what an object *is*, not what it can *do*.

The actions your object can do are called its *methods*. So let's teach your object a few useful methods:

```
# Adding a new method:
Add-Member -memberType ScriptMethod -In $pocketknife `
  -name cut -Value { "I'm whittling now" }
# Specify arguments without parameter names by position data:
Add-Member -in $pocketknife ScriptMethod screw { "Phew...it's in!" }
# Specifying "InputObject" directly through the pipeline:
$pocketknife | Add-Member ScriptMethod corkscrew { "Pop! Cheers!" }
```

Again, you used the *Add-Member* cmdlet, but this time you added a method instead of a property (in this case, a *ScriptMethod*). The value is a scriptblock marked by braces, which contains the PowerShell instructions you want the method to perform. If you output your object, it will still look the same because PowerShell only visualizes object properties, not methods:

```
$pocketknife

  Color        Weight       Manufacturer        Blades
  -----        ------       ------------        -------
  Red          55           Idera               3
```

To use any of the three newly added methods, add a dot and then the method name followed by two parentheses, which are what distinguish properties from methods. For example, if you'd like to remove a cork with your virtual pocketknife, enter this instruction:

```
$pocketknife.corkscrew()

  Pop! Cheers!
```

Your object really does carry out the exact script commands you assigned to the *corkscrew()* method. So, methods perform actions, while properties merely provide information. Always remember to add parentheses to method names. If you forget them, something interesting happens:

```
# If you don't use parentheses, you'll retrieve information on a method:
$pocketknife.corkscrew

  Script              : "Pop! Cheers!"
  OverloadDefinitions : {System.Object corkscrew();}
  MemberType          : ScriptMethod
  TypeNameOfValue     : System.Object
  Value               : System.Object corkscrew();
  Name                : corkscrew
  IsInstance          : True
```

You just received a method description. What's interesting about this is mainly the *OverloadDefinitions* property. As you'll see later, it reveals the exact way to use a command for any method. In fact, the *OverloadDefinitions* information is in an additional object. For PowerShell, absolutely everything is an object so you could store the object in a variable and then specifically ask the *OverloadDefinitions* property for information:

```
# Information about a method is returned in an object of its own:
$info = $pocketknife.corkscrew
$info.OverloadDefinitions

  System.Object corkscrew();
```

The "virtual pocketknife" example reveals that objects are containers that contain data (properties) and actions (methods).

Our virtual pocketknife was a somewhat artificial object with no real use. Next, let's take a look at a more interesting object which PowerShell stores in the variable *$host*.

Properties: What an Object "Is"

Properties describe an object. Object properties are automatically converted into text when you output the object to the console. That's enough to investigate any object. Check out the properties in *$host*!

```
$host

  Name             : ConsoleHost
  Version          : 1.0.0.0
  InstanceId       : e32debaf-3d10-4c4c-9bc6-ea58f8f17a8f
  UI               : System.Management.Automation.Internal.
                       Host.InternalHostUserInterface
  CurrentCulture   : en-US
  CurrentUICulture : en-US
  PrivateData      : Microsoft.PowerShell.ConsoleHost+ConsoleColorProxy
```

The object stored in the variable *$host* apparently contains seven properties. The properties' names are listed in the first column. So, if you want to find out which PowerShell version you're using, you could access and return the *Version* property:

```
$host.Version

  Major  Minor  Build  Revision
  -----  -----  -----  --------
  1      0      0      0
```

It works—the version is displayed. However, the version isn't displayed as a single number. Rather, PowerShell displays four columns: *Major*, *Minor*, *Build* and *Revision*. Whenever you see columns, you know these are the object properties that PowerShell has just converted into text. Let's check out the data type that the *Version* property uses:

```
$version = $host.Version
$version.GetType().FullName

  System.Version
```

The version is not stored as a *String* object but as a *System.Version* object. This object type is perfect for storing versions, allowing you to easily read all details about any given version:

```
$host.Version.Major

  1

$host.Version.Build

  0
```

Knowing an object type is very useful because once you know there is a type called *System.Version*, you can use it for your own purposes as well. Try and convert a simple *string* of your choice into a rich *version* object! To do that, simply make sure the string consists of four numbers separated by dots (the typical format for versions), then make PowerShell convert the string into a System.Version type. You convert things by adding the target type in square brackets in front of the string:

```
[System.Version]'12.55.3.28334'

  Major  Minor  Build  Revision
  -----  -----  -----  --------
  12     55     3      28334
```

The *CurrentCulture* property is just another example of the same concept. Read this property and find out its type:

```
$host.CurrentCulture

  LCID             Name             DisplayName
  ----             ----             -----------
  1033             en-US            English (United States)

$host.CurrentCulture.GetType().FullName

  System.Globalization.CultureInfo
```

Country properties are again stored in a highly specialized type that describes a culture with the properties *LCID*, *Name*, and *DisplayName*. If you wanted to know which international version of PowerShell you are using, read the *DisplayName* property:

```
$host.CurrentCulture.DisplayName

  English (United States)

$host.CurrentCulture.DisplayName.GetType().FullName
```

```
    System.String
```

Likewise, you could convert any suitable string into a *CultureInfo*-object. So if you wanted to find out details about the 'de-DE' locale, do this:

```
  [System.Globalization.CultureInfo]'de-DE'

    LCID              Name              DisplayName
    ----              ----              -----------
    1031              de-DE             German (Germany)
```

You could also convert the LCID into a *CultureInfo* object by converting a suitable number:

```
  [System.Globalization.CultureInfo]1033

    LCID              Name              DisplayName
    ----              ----              -----------
    1033              en-US             English (United States)
```

Properties Containing Objects

The properties of an object store data, and this data is, in turn, stored in various other objects. Two properties in *$host* seem to be special: *UI* and *PrivateData*. When you output $host into the console, all other properties are converted into readable text - except for the properties UI and PrivateData:

```
  $host

    Name             : ConsoleHost
    Version          : 1.0.0.0
    InstanceId       : e32debaf-3d10-4c4c-9bc6-ea58f8f17a8f
    UI               : System.Management.Automation.Internal.
                         Host.InternalHostUserInterface
    CurrentCulture   : en-US
    CurrentUICulture : en-US
    PrivateData      : Microsoft.PowerShell.ConsoleHost+ConsoleColorProxy
```

The reason is that both these properties contain an object that, as the only property, provides, in turn, an object. If you'd like to find out what is actually stored in the *UI* property, read the property:

```
  $host.UI

    RawUI
    -----
    System.Management.Automation.Internal.
      Host.InternalHostRawUserInterface
```

You see that the property *UI* contains only a single property called *RawUI*, in which yet another object is stored. Let's see what sort of object is stored in the *RawUI* property:

```
  $host.ui.rawui
```

```
    ForegroundColor       : DarkYellow
    BackgroundColor       : DarkMagenta
    CursorPosition        : 0,136
    WindowPosition        : 0,87
    CursorSize            : 25
    BufferSize            : 120,3000
    WindowSize            : 120,50
    MaxWindowSize         : 120,62
    MaxPhysicalWindowSize : 140,62
    KeyAvailable          : False
    WindowTitle           : PowerShell
```

"RawUI" stands for "Raw User Interface" and exposes the raw user interface settings your PowerShell console uses. You can read all of these properties, but can you also change them?

Read-Only and Read-Write Properties

Can you actually change properties, too? And if you can, what happens then?

Properties need to accurately describe an object, so if you modify a property, the underlying object has to also be modified to reflect that change. If that is not possible, the property cannot be changed and is called "read-only."

Console background and foreground colors are a great example of properties you can easily change. If you do, the console will change colors accordingly. Your property changes are reflected by the object, and the changed properties still accurately describe the object.

```
  $host.ui.rawui.BackgroundColor = "Green"
  $host.ui.rawui.ForegroundColor = "White"
```

Type *cls* so the entire console adopts this color scheme.

Other properties cannot be changed. If you try anyway, you'll get an error message:

```
  $host.ui.rawui.keyavailable = $true

    "KeyAvailable" is a ReadOnly-property.
    At line:1 char:16
    + $host.ui.rawui.k <<<< eyavailable = $true
```

Whether the console receives key press input, or not, depends on whether you pressed a key or not. You cannot control that by changing a property, so this property refuses to be changed. You can only read it.

Property	Description
ForegroundColor	Text color. Optional values are *Black*, *DarkBlue*,

	DarkGreen, *DarkCyan*, *DarkRed*, *DarkMagenta*, *DarkYellow*, *Gray*, *DarkGray*, *Blue*, *Green*, *Cyan*, *Red*, *Magenta*, *Yellow*, and *White*.
BackgroundColor	Background color. Optional values are *Black*, *DarkBlue*, *DarkGreen*, *DarkCyan*, *DarkRed*, *DarkMagenta*, *DarkYellow*, *Gray*, *DarkGray*, *Blue*, *Green*, *Cyan*, *Red*, *Magenta*, *Yellow*, and *White*.
CursorPosition	Current position of the cursor
WindowPosition	Current position of the window
CursorSize	Size of the cursor
BufferSize	Size of the screen buffer
WindowSize	Size of the visible window
MaxWindowSize	Maximally permissible window size
MaxPhysicalWindowSize	Maximum possible window size
KeyAvailable	Makes key press input available
WindowTitle	Text in the window title bar

Table 6.1: Properties of the RawUI object

Property Types

Some properties accept numeric values. For example, the size of a blinking cursor is specified as a number from *0* to *100* and corresponds to the fill percentage. The next line sets a cursor size of 75%. Values outside the 0-100 numeric range generate an error:

```
# A value from 0 to 100 is permitted:
$host.ui.rawui.cursorsize = 75
# Values outside this range will generate an error:
$host.ui.rawui.cursorsize = 1000
```

```
Exception setting "CursorSize": "Cannot process "CursorSize"
  because the cursor size specified is invalid.
Parameter name: value
Actual value was 1000."
At line:1 char:16
+ $host.ui.rawui.c <<<< ursorsize = 1000
```

Other properties expect color settings. You cannot specify any color that comes to your mind, though. Instead, PowerShell expects a "valid" color, and if your color is unknown, you receive an error message listing the colors you can use:

```
# Colors are specified as text (in quotation marks):
$host.ui.rawui.ForegroundColor = "yellow"
# Not all colors are allowed:
$host.ui.rawui.ForegroundColor = "pink"

  Exception setting "ForegroundColor": "Cannot convert value "pink" to
    type "System.ConsoleColor" due to invalid enumeration values. Specify
    one of the following enumeration values and try again. The possible
    enumeration values are "Black, DarkBlue, DarkGreen, DarkCyan, DarkRed,
    DarkMagenta, DarkYellow, Gray, DarkGray, Blue, Green, Cyan, Red,
    Magenta, Yellow, White."
  At line:1 char:16
  + $host.ui.rawui.F <<<< oregroundColor = "pink"
```

tip If you assign an invalid value to the property *ForegroundColor*, the error message lists the possible values. If you assign an invalid value to the property *CursorSize*, you get no hint. Why?

Every property expects a certain object type. Some object types are more specific than others. Use *Get-Member* to find out which object types a given property expects:

```
$host.ui.RawUI | Get-Member -memberType Property

  TypeName: System.Management.Automation.Internal.Host.
               InternalHostRawUserInterface
  Name                    MemberType Definition
  ----                    ---------- ----------
  BackgroundColor         Property   System.ConsoleColor
                                       BackgroundColor {get;set;}
  BufferSize              Property   System.Management.Automation.
                                       Host.Size BufferSize
                                       {get;set;}
  CursorPosition          Property   System.Management.Automation.
                                       Host.Coordinates
                                       CursorPosition {get;set;}
  CursorSize              Property   System.Int32 CursorSize
  {get;set;}
  ForegroundColor         Property   System.ConsoleColor
                                       ForegroundColor {get;set;}
```

```
    KeyAvailable          Property   System.Boolean
                                       KeyAvailable {get;}
    MaxPhysicalWindowSize Property   System.Management.Automation.
                                       Host.Size
    MaxPhysicalWindowSize
                                       {get;}
    MaxWindowSize         Property   System.Management.Automation.
                                       Host.Size MaxWindowSize
                                       {get;}
    WindowPosition        Property   System.Management.Automation.
                                       Host.Coordinates
                                       WindowPosition {get;set;}
    WindowSize            Property   System.Management.Automation.
                                       Host.Size WindowSize
                                       {get;set;}
    WindowTitle           Property   System.String WindowTitle
                                       {get;set;}
```

As you see, *ForegroundColor* expects a *System.ConsoleColor* type. This type is a highly specialized type, a list of possible values, a so called enumeration:

```
  [system.ConsoleColor].IsEnum

    True
```

Whenever a type is an enumeration, you can use a special .NET method called *GetNames()* to list the possible values defined in that enumeration:

```
  [System.Enum]::GetNames([System.ConsoleColor])

    Black
    DarkBlue
    DarkGreen
    DarkCyan
    DarkRed
    DarkMagenta
    DarkYellow
    Gray
    DarkGray
    Blue
    Green
    Cyan
    Red
    Magenta
    Yellow
    White
```

If you specify anything not contained in the enumeration, the error message will simply return the enumeration's contents.

CursorSize stores its data in a *System.Int32* object, which is simply a 32bit number. So, if you try to set the cursor size to 1000, you are actually not violating the object boundaries because the value of 1000 can be stored in a *System.Int32* object. You get an error message anyway because of the validation code that the *CursorSize* property executes internally. So, whether you get detailed error information really depends on the property's definition. In the case of *CursorSize*, you would receive only an indication that your value is invalid, but not the reason why.

Sometimes, a property expects a value wrapped in a specific object. For example, if you'd like to change the PowerShell window size, you could use the *WindowSize* property. As it turns out, the property expects a new window size wrapped in an object of type *System.Management.Automation.Host.Size*. Where can you get an object like that?

```
$host.ui.rawui.WindowSize = 100,100

  Exception setting "WindowSize": "Cannot convert "System.Object[]"
    to "System.Management.Automation.Host.Size"."
  At line:1 char:16
  + $host.ui.rawui.W <<<< indowSize = 100,100
```

tip

There are a number of ways to provide specialized objects for properties. The easiest approach: read the existing value of a property (which will get you the object type you need), change the result, and then write back the changes. For example, here's how you would change the PowerShell window size to 80 x 30 characters:

```
$value = $host.ui.rawui.WindowSize
$value

      Width     Height
      -----     ------
        110         64

$value.Width = 80
$value.Height = 30
$host.ui.rawui.WindowSize = $value
```

Or, you can freshly create the object you need by using New-Object:

```
$value = New-Object `
  System.Management.Automation.Host.Size(80,30)
$host.ui.rawui.WindowSize = $value
```

Or in a line:

```
$host.ui.rawui.WindowSize = New-Object `
  System.Management.Automation.Host.Size(80,30)
```

Listing All Properties

Because properties and methods are all members of an object, *Get-Member* returns detailed information about them. Let's use *Get-Member* to examine all properties defined in *$host*. To limit *Get-Member* to only properties, use the *memberType* parameter and specify "property":

```
$host | Get-Member -memberType property

   Name              MemberType Definition
   ----              ---------- ----------
   CurrentCulture    Property   System.Globalization.CultureInfo
                                  CurrentCulture {get;}
   CurrentUICulture  Property   System.Globalization.CultureInfo
                                  CurrentUICulture {get;}
   InstanceId        Property   System.Guid InstanceId {get;}
   Name              Property   System.String Name {get;}
   PrivateData       Property   System.Management.Automation.PSObject
                                  PrivateData {get;}
   UI                Property   System.Management.Automation.Host.
                                  PSHostUserInterface UI {get;}
   Version           Property   System.Version Version {get;}
```

In the column *Name*, you now see all supported properties in *$host*. In the column *Definition*, the property object type is listed first. For example, you can see that the *Name* property stores a text as *System.String* type. The *Version* property uses the *System.Version* type.

At the end of each definition, braces report whether the property is read-only ({get;}) or can also be modified ({get;set;}). You can see at a glance that all properties of the *$host* object are only readable. Now, take a look at the *$host.ui.rawui* object:

```
$host.ui.rawui | Get-Member -memberType property

   BackgroundColor       Property   System.ConsoleColor BackgroundColor
                                      {get;set;}
   BufferSize            Property   System.Management.Automation.Host.
                                      Size BufferSize {get;set;}
   CursorPosition        Property   System.Management.Automation.Host.
                                      Coordinates CursorPosition {get;set;}
   CursorSize            Property   System.Int32 CursorSize {get;set;}
   ForegroundColor       Property   System.ConsoleColor ForegroundColor {get;set;}
   KeyAvailable          Property   System.Boolean KeyAvailable {get;}
   MaxPhysicalWindowSize Property   System.Management.Automation.Host.Size
                                      MaxPhysicalWindowSize {get;}
   MaxWindowSize         Property   System.Management.Automation.Host.Size
```

```
                                          MaxWindowSize {get;}
WindowPosition         Property   System.Management.Automation.Host.
                                    Coordinates WindowPosition {get;set;}
WindowSize             Property   System.Management.Automation.Host.Size
                                    WindowSize {get;set;}
WindowTitle            Property   System.String WindowTitle {get;set;}
```

This result is more differentiated. It shows you that some properties could be changed, while others could not.

pro tip

There are different "sorts" of properties. Most properties are of the *Property* type, but PowerShell can add additional properties like *ScriptProperty*. So if you really want to list all properties, use the *memberType* parameter and assign it a value of **Property*. The wildcard in front of "property" will also select all specialized properties like "ScriptProperty".

Methods: What an Object "Can Do"

Methods are things that an object *can do*. When you output an object to the console, only its properties are converted into readable text. Its methods remain invisible. To list the methods of an object, use *Get-Member* and use the parameter "memberType" with the value "method":

```
$host | Get-Member -memberType Method
```

```
Name                    MemberType Definition
----                    ---------- ----------
EnterNestedPrompt       Method     System.Void EnterNestedPrompt()
Equals                  Method     System.Boolean Equals(Object obj)
ExitNestedPrompt        Method     System.Void ExitNestedPrompt()
GetHashCode             Method     System.Int32 GetHashCode()
GetType                 Method     System.Type GetType()
get_CurrentCulture      Method     System.Globalization.CultureInfo
                                     get_CurrentCulture()
get_CurrentUICulture    Method     System.Globalization.CultureInfo
                                     get_CurrentUICulture()
get_InstanceId          Method     System.Guid get_InstanceId()
get_Name                Method     System.String get_Name()
get_PrivateData         Method     System.Management.Automation.PSObject
                                     get_PrivateData()
get_UI                  Method     System.Management.Automation.Host.
                                     PSHostUserInterface get_UI()
get_Version             Method     System.Version get_Version()
NotifyBeginApplication Method     System.Void NotifyBeginApplication()
NotifyEndApplication    Method     System.Void NotifyEndApplication()
SetShouldExit           Method     System.Void SetShouldExit(Int32
                                     exitCode)
```

```
    ToString                   Method      System.String ToString()
```

Eliminating "Internal" Methods

Get-Member lists all methods defined by an object. Not all of them are really useful to you. Let's check out why some of the listed methods are really only of limited use.

Get_ and Set_ Methods

Any method that starts with "get_" is really a method to retrieve a property value. So the method "get_someInfo()" is getting you the very same information you could also have retrieved with the "someInfo" property.

```
  # Query property:
  $host.version

    Major  Minor  Build  Revision
    -----  -----  -----  --------
    1      0      0      0

  # Query property value using getter method:
  $host.get_Version()

    Major  Minor  Build  Revision
    -----  -----  -----  --------
    1      0      0      0
```

The same is true for *Set_* methods: they change a property value and exist for properties that are read/writeable. Note in this example: all properties of the *$host* object can only be read so there are no Set_ methods. There can be more internal methods like this, such as Add_ and Remove_ methods. Generally speaking, when a method name contains an underscore, it most likely is an internal method.

Standard Methods

In addition, nearly every object contains a number of "inherited" methods that are also not specific to the object but perform general tasks for every object:

Method	Description
Equals	Verifies whether the object is identical to a comparison object
GetHashCode	Retrieves an object's digital "fingerprint"

GetType	Retrieves the underlying object type
ToString	Converts the object into readable text

Table 6.2: Standard methods of a .NET object

To sort out all methods that contain an underscore, you could use *Where-Object* and the comparison operator -notlike:

```
$host | Get-Member -memberType *method |
  Where-Object { $_.Name -notlike '*_*'  }
```

The *$host* object really only contains these unique and useful methods:

```
Name                    MemberType Definition
----                    ---------- ----------
EnterNestedPrompt       Method     System.Void EnterNestedPrompt()
ExitNestedPrompt        Method     System.Void ExitNestedPrompt()
NotifyBeginApplication  Method     System.Void NotifyBeginApplication()
NotifyEndApplication    Method     System.Void NotifyEndApplication()
SetShouldExit           Method     System.Void SetShouldExit(Int32
                                     exitCode)
```

Calling a Method

Watch out: *before* you invoke a method: make sure you know what the method will do. Methods are commands that do something, and what a command does can be dangerous. To call a method, add a dot to the object and then the method name. Add an opened and closed parenthesis, like this:

```
$host.EnterNestedPrompt()
```

The PowerShell prompt changes to ">>". You have used *EnterNestedPrompt()* to open a nested prompt. Nested prompts are not especially useful in a normal console, so exit it again using the *exit* command or call *$host.ExitNestedPrompt()*.

Nested prompts are very useful in functions or scripts because they work like breakpoints and can temporarily stop a function or script so you can verify variable contents or make code changes, after which you continue the code by entering *exit*. You'll learn more about this in Chapter 11.

Call Methods with Arguments

There are a bunch of useful methods in the *UI* object. Here's how you get a good overview:

```
$host.ui | Get-Member -memberType Method
```

```
   TypeName: System.Management.Automation.Internal.Host.
             InternalHostUserInterface
   Name                   MemberType Definition
   ----                   ---------- ----------
   Equals                 Method     System.Boolean Equals(Object obj)
   GetHashCode            Method     System.Int32 GetHashCode()
   GetType                Method     System.Type GetType()
   get_RawUI              Method     System.Management.Automation.Host.
                                       PSHostRawUserInterface get_RawUI()
   Prompt                 Method     System.Collections.Generic.Dictionary
                                       `2[[System.String, mscorlib, ...
   PromptForChoice        Method     System.Int32 PromptForChoice(String
                                       caption, String message, ...
   PromptForCredential    Method     System.Management.Automation.
                                       PSCredential PromptForCredential...
   ReadLine               Method     System.String ReadLine()
   ReadLineAsSecureString Method     System.Security.SecureString
                                       ReadLineAsSecureString()
   ToString               Method     System.String ToString()
   Write                  Method     System.Void Write(String value),
                                       System.Void Write(ConsoleColor...
   WriteDebugLine         Method     System.Void WriteDebugLine(String
                                       message)
   WriteErrorLine         Method     System.Void WriteErrorLine(String
                                       value)
   WriteLine              Method     System.Void WriteLine(), System.Void
                                       WriteLine(String value)...
   WriteProgress          Method     System.Void WriteProgress(Int64
                                       sourceId, ProgressRecord record)
   WriteVerboseLine       Method     System.Void WriteVerboseLine(String
                                       message)
   WriteWarningLine       Method     System.Void WriteWarningLine(String
                                       message)
```

Most methods require additional arguments from you, which are listed in the *Definition* column.

Which Arguments are Required?

Pick out a method from the list, and ask *Get-Member* to get you more info. Let's pick *WriteDebugLine()*:

```
# Ask for data on the WriteDebugLine method
# in $host.ui:
$info = $host.UI | Get-Member WriteDebugLine
# $info contains all the data on this method:
$info

   TypeName: System.Management.Automation.
     Internal.Host.InternalHostUserInterface
   Name           MemberType Definition
   ----           ---------- ----------
```

```
  WriteDebugLine Method      System.Void
                             WriteDebugLine
                             (String message)

# Definition shows which arguments are required
# and which result will be returned:
$info.Definition

  System.Void WriteDebugLine(String message)
```

The *Definition* property tells you how to call the method. Every definition starts with the object type that a method returns. In this example it is *System.Void*, a special object type because it represents "nothing": the method doesn't return anything at all. A method "returning" *System.Void* is really a procedure, not a function.

Next, a method's name follows, which is then followed by required arguments. *WriteDebugLine* needs exactly one argument called *message*, which is of *String* type. Here is how you call *WriteDebugLine()*:

```
$host.ui.WriteDebugLine("Hello!")

  Hello!
```

Low-Level Functions

WriteDebugLine() really does nothing spectacular. In fact, most methods found in the *$host* object are really only low-level commands used by the standard PowerShell cmdlets. For example, you could also have output the debug notification by using the following cmdlet:

```
Write-Debug "Hello!"
```

However, there are differences: No matter what—*WriteDebugText()* always writes out yellow debug messages. The high-level *Write-Debug* cmdlet only outputs the debug message when the *$DebugPreference* variable is set to anything other than "SilentlyContinue" (which is the default).

The same applies to the *WriteErrorLine*, *WriteVerboseLine*, and *WriteWarningLine* methods, which are the low-level functions for the *Write-Error*, *Write-Verbose*, and *Write-Warning* cmdlets.

So, if you'd like to output error or warning messages that are independent of the various preference settings in PowerShell, use the low-level commands in *$host.UI.RawUI* instead of the cmdlets.

Several Method "Signatures"

Some methods accept different argument types or even different numbers of arguments. To find out which "signatures" a method supports, use *Get-Member* again and look at the *Definition* property:

```
$info = $host.UI | Get-Member WriteLine
$info.Definition
```

```
    System.Void WriteLine(),
    System.Void WriteLine(String value),
    System.Void WriteLine(
      ConsoleColor foregroundColor,
      ConsoleColor backgroundColor,
      String value)
```

Unfortunately, the definition is hard to read at first. Make it more readable by using *Replace()* to add line breaks.

Remember the strange "backtick" character ("`"). It introduces special characters; "`n" stands for a line break.

```
$info.Definition.Replace("), ", ")`n")

    System.Void WriteLine()
    System.Void WriteLine(String value)
    System.Void WriteLine(
      ConsoleColor foregroundColor,
      ConsoleColor backgroundColor,
      String value)
```

This definition tells you: You do not necessarily need to supply arguments:

```
$host.ui.WriteLine()
```

The result is an empty line.

To output text, you specify one argument only, the text itself:

```
$host.ui.WriteLine("Hello world!")

    Hello world!
```

The third variant adds support for foreground and background colors:

```
$host.ui.WriteLine("Red", "White", "Alarm!")
```

WriteLine() actually is the low-level function of the *Write-Host* cmdlet:

```
Write-Host
Write-Host "Hello World!"
Write-Host -foregroundColor Red `
  -backgroundColor White Alarm!
```

Playing with PromptForChoice

Most methods you examined so far turned out to be low-level commands for cmdlets. This is also true for the following methods: *Write()* (corresponds to *Write-Host -noNewLine*) or *ReadLine()/ReadLineAsSecureString()* (*Read-Host -asSecureString*) or *PromptForCredential()* (*Get-Credential*).

A new functionality is exposed by the method *PromptForChoice()*. Let's first examine which arguments this method expects:

```
$info = $host.UI | Get-Member PromptForChoice
$info.Definition

  System.Int32 PromptForChoice(String caption,
    String message, Collection`1 choices,
    Int32 defaultChoice)
```

tip You can get the same information if you call the method without parentheses:

```
$host.ui.PromptForChoice

MemberType            : Method
OverloadDefinitions   : {System.Int32 PromptForChoice(
                          String caption, String message,
                          Collection`1 choices,
                          Int32 defaultChoice)}
TypeNameOfValue       : System.Management.Automation.PSMethod
Value                 : System.Int32 PromptForChoice(
                          String caption, String message,
                           Collection`1 choices,
                           Int32 defaultChoice)
Name                  : PromptForChoice
IsInstance            : True
```

The definition reveals that this method returns a numeric value (*System.Int32*). It requires a heading and a message respectively as text (*String*). The third argument is a bit strange: *Collection`1 choices*. The fourth argument is a number (*Int32*), the standard selection. You should have noticed by now the limitations of PowerShell's built-in description.

This is how you could use *PromptForChoice()* to create a simple menu:

```
$yes = ([System.Management.Automation.Host.ChoiceDescription]"&yes")
$no = ([System.Management.Automation.Host.ChoiceDescription]"&no")
$selection = [System.Management.Automation.Host.ChoiceDescription[]] `
  ($yes,$no)
$answer = $host.ui.PromptForChoice('Reboot',
  'May the system now be rebooted?',$selection,1)
```

```
$selection[$answer]
if ($selection -eq 0) {
  "Reboot"
} else {
  "OK, then not"
}
```

Working with Real-Life Objects

Every single PowerShell command returns objects, which is a good thing. However, it is not that easy to get your hands on objects because whenever objects hit the PowerShell console, they will be converted to text and lose a lot of their information.

Storing Results in Variables

Do not output command results to the console to prevent PowerShell from converting objects into simple strings. The console is a hostile place for objects because anything output to the PowerShell console will end up as text. Instead, save the command result in a variable, which is a safe place for objects.

```
$listing = Dir
```

However, variables are only safe places for objects until you dump their content to the console: the objects stored inside of your variable would again be converted to text.

```
$listing

  Directory: Microsoft.PowerShell.Core\FileSystem::
                C:\Users\Tobias Weltner
  Mode           LastWriteTime   Length Name
  ----           -------------   ------ ----
  d----   04.03.2009     11:37          Application Data
  d----   05.03.2009     11:03          Backup
  d-r--   13.02.2009     15:05          Contacts
  d----   28.01.2009     18:33          Debug
  (...)
```

So, to get in touch with the real objects, you can directly access them inside of a variable. *Dir* has stored its directory listing in *$listing*. Since the listing consists of more than one entry, it is wrapped in an array. Access an array element to get your hands on a real object:

```
# Access first element in listing
$object = $listing[0]
# Object is converted into text when you output it in the console
$object

  Directory: Microsoft.PowerShell.Core\FileSystem::
               C:\Users\Tobias Weltner
  Mode          LastWriteTime   Length Name
```

```
    ----         -------------  ------ ----
    d----  0.07.2007     11:37         Application Data
```

The object picked here happens to match the folder *Application Data*; so it represents a directory. If you would prefer to directly pick a particular directory or file, you can do this:

```
  # Address a particular file:
  $object = Dir c:\autoexec.bat
  # Address the Windows directory:
  $object = Get-Item $env:winDir
```

Using Object Properties

You can now use *Get-Member* again to produce a list of all available properties:

```
  # $object is a fully functional object that
  # describes the "Application Data" directory
  # First, list all object properties:
  $object | Get-Member -memberType *property

    TypeName: System.IO.DirectoryInfo
    Name               MemberType     Definition
    ----               ----------     ----------
    PSChildName        NoteProperty   System.String PSChildName=
                                        Application Data
    PSDrive            NoteProperty   System.Management.Automation.
                                        PSDriveInfo PSDrive=C
    PSIsContainer      NoteProperty   System.Boolean PSIsContainer=
                                        True
    PSParentPath       NoteProperty   System.String PSParentPath=
                                        Microsoft.PowerShell.Core\
                                        FileSystem::C:\Users...
    PSPath             NoteProperty   System.String PSPath=Microsoft.
                                        PowerShell.Core\FileSystem::
                                        C:\Users\Tobia...
    PSProvider         NoteProperty   System.Management.Automation.
                                        ProviderInfo PSProvider=
                                        Microsoft.PowerShell...
    Attributes         Property       System.IO.FileAttributes
                                        Attributes {get;set;}
    CreationTime       Property       System.DateTime CreationTime
                                        {get;set;}
    CreationTimeUtc    Property       System.DateTime CreationTimeUtc
                                        {get;set;}
    Exists             Property       System.Boolean Exists {get;}
    Extension          Property       System.String Extension {get;}
    FullName           Property       System.String FullName {get;}
    LastAccessTime     Property       System.DateTime LastAccessTime
                                        {get;set;}
    LastAccessTimeUtc  Property       System.DateTime LastAccessTimeUtc
                                        {get;set;}
  LastWriteTime     Property       System.DateTime LastWriteTime
                                     {get;set;}
  LastWriteTimeUtc  Property       System.DateTime LastWriteTimeUtc
                                     {get;set;}
  Name              Property       System.String Name {get;}
  Parent            Property       System.IO.DirectoryInfo
                                     Parent {get;}
  Root              Property       System.IO.DirectoryInfo
                                     Root {get;}
  Mode              ScriptProperty System.Object Mode
                                     {get=$catr = "";...
```

Properties marked with *{get;set;}* in the column *Definition* may also be modified:

```
# Determine last access date:
$object.LastAccessTime

  Wednesday, January 14, 2009 11:37:39

# Change Date:
$object.LastAccessTime = Get-Date
# Change was accepted:
$object.LastAccessTime

  Saturday, March 7, 2009 15:31:41
```

PowerShell-Specific Properties

PowerShell can add additional properties to an object. Whenever that occurs, *Get-Member* labels the property accordingly in the MemberType column. Native properties are just called "Property." Properties added by PowerShell use a prefix, such as "ScriptProperty" or "NoteProperty."

A *NoteProperty* like *PSChildName* contains static data. PowerShell adds it to tag additional information to an object. A *ScriptProperty* like *Mode* executes PowerShell script code that calculates the property's value.

If you want to see the script code being executed when you call the *ScriptProperty Mode*, ask *Get-Member* to list the property definition:

```
$info = $object | Get-Member Mode
$info.Definition

  System.Object Mode {get=$catr = "";
    if ( $this.Attributes -band 16 ) { $catr += "d" }
      else { $catr += "z" };
    if ( $this.Attributes -band 32 ) { $catr += "a" }
      else { $catr += "-" };
    if ( $this.Attributes -band 1 )  { $catr += "r" }
      else { $catr += "-" };
    if ( $this.Attributes -band 2 )  { $catr += "h" }
```

```
      else { $catr += "-" };
    if ( $this.Attributes -band 4 )  { $catr += "s" }
      else { $catr += "-" };
    $catr;}
```

As it turns out, *Mode* evaluates the native *Attributes* property which is a bitmask. Binary bitmasks are hard to read so that is why the new Mode script property converts the binary information into a more user friendly format.

MemberType	Description
AliasProperty	Alternative name for a property that already exists
CodeProperty	Static .NET method returns property contents
Property	Genuine property
NoteProperty	Subsequently added property with set data value
ScriptProperty	Subsequently added property whose value is calculated by a script
ParameterizedProperty	Property requiring additional arguments

Table 6.3: Different property types

Using Object Methods

Use *Get-Member* again to find out the methods that an object supports:

```
# List all methods of the object:
$object | Get-Member -memberType *method

  TypeName: System.IO.DirectoryInfo
  Name                        MemberType Definition
  ----                        ---------- ----------
  Create                      Method     System.Void Create(),
                                           System.Void Create(
                                           DirectorySecurity DirectoryS...
  CreateObjRef                Method     System.Runtime.Remoting.ObjRef
                                           CreateObjRef(Type requestedType)
  CreateSubDirectory          Method     System.IO.DirectoryInfo
```

```
                                        CreateSubDirectory(String path),
                                        System.IO.Di...
Delete                    Method      System.Void Delete(), System.Void
                                        Delete(Boolean recursive)
Equals                    Method      System.Boolean Equals(Object obj)
GetAccessControl          Method      System.Security.AccessControl.
                                        DirectorySecurity GetAccessCo...
GetDirectories            Method      System.IO.DirectoryInfo[]
                                        GetDirectories(), System.IO.
                                        DirectoryInfo[]...
GetFiles                  Method      System.IO.FileInfo[] GetFiles(
                                        String searchPattern), System.IO.
                                        FileIn...
GetFileSystemInfos        Method      System.IO.FileSystemInfo[]
                                        GetFileSystemInfos(String
                                        searchPattern), ...
GetHashCode               Method      System.Int32 GetHashCode()
GetLifetimeService        Method      System.Object GetLifetimeService()
GetObjectData             Method      System.Void GetObjectData(
                                        SerializationInfo info,
                                        StreamingContext co...
GetType                   Method      System.Type GetType()
get_Attributes            Method      System.IO.FileAttributes
                                        get_Attributes()
get_CreationTime          Method      System.DateTime get_CreationTime()
get_CreationTimeUtc       Method      System.DateTime get_CreationTimeUtc()
get_Exists                Method      System.Boolean get_Exists()
get_Extension             Method      System.String get_Extension()
get_FullName              Method      System.String get_FullName()
get_LastAccessTime        Method      System.DateTime get_LastAccessTime()
get_LastAccessTimeUtc     Method      System.DateTime
                                        get_LastAccessTimeUtc()
get_LastWriteTime         Method      System.DateTime get_LastWriteTime()
get_LastWriteTimeUtc      Method      System.DateTime
                                        get_LastWriteTimeUtc()
get_Name                  Method      System.String get_Name()
get_Parent                Method      System.IO.DirectoryInfo get_Parent()
get_Root                  Method      System.IO.DirectoryInfo get_Root()
InitializeLifetimeService Method      System.Object
                                        InitializeLifetimeService()
MoveTo                    Method      System.Void MoveTo(String destDirName)
Refresh                   Method      System.Void Refresh()
SetAccessControl          Method      System.Void SetAccessControl(
                                        DirectorySecurity DirectorySecurity)
set_Attributes            Method      System.Void set_Attributes(
                                        FileAttributes value)
set_CreationTime          Method      System.Void set_CreationTime(
                                        DateTime value)
set_CreationTimeUtc       Method      System.Void set_CreationTimeUtc(
                                        DateTime value)
set_LastAccessTime        Method      System.Void set_LastAccessTime(
                                        DateTime value)
set_LastAccessTimeUtc     Method      System.Void set_LastAccessTimeUtc(
                                        DateTime value)
set_LastWriteTime          Method     System.Void set_LastWriteTime(
                                        DateTime value)
set_LastWriteTimeUtc       Method     System.Void set_LastWriteTimeUtc(
                                        DateTime value)
ToString                   Method     System.String ToString()
```

note

Again, standard methods are displayed in bold font so you can safely ignore them because they exist in every object or match properties.

You can apply methods just like you did in the previous examples. For example, use the *CreateSubDirectory* method if you'd like to create a new subdirectory. Find out first which arguments this method requires and what it returns:

```
$info = $object | Get-Member CreateSubDirectory
$info.Definition.Replace("), ", ")`n")

  System.IO.DirectoryInfo CreateSubDirectory(String path)
  System.IO.DirectoryInfo CreateSubDirectory(String path,
    DirectorySecurity DirectorySecurity)
```

You can see that the method has two signatures. Use the first to create a subdirectory and the second to add access permissions.

The next line creates a subdirectory called "My New Directory" without any special access privileges:

```
$object.CreateSubDirectory("My New Directory")

  Mode      LastWriteTime  Length Name
  ----      -------------  ------ ----
  d----   03.07.200915:49         My New Directory
```

Because the method returns a *DirectoryInfo* object as result and you haven't caught and stored this object in a variable, the pipeline converts it into text and outputs it. You could just as well have stored the result of the method in a variable:

```
$subdirectory = $object.CreateSubDirectory("Another subdirectory")
$subdirectory.CreationTime = "September 1, 1980"
$subdirectory.CreationTime

  Monday, September 1, 1980 00:00:00
```

Different Method Types

Similarly to properties, PowerShell can also add additional methods to an object.

MemberType	Description
CodeMethod	Method mapped to a static .NET method
Method	Genuine method
ScriptMethod	Method invokes PowerShell code

Table 6.4: Different types of methods

Using Static Methods

By now, you know that PowerShell stores information in objects, and objects always have a type. You know that simple text is stored in objects of type *System.String* and that a date, for example, is stored in an object of type *System.DateTime*. You also know by now that each .NET object has a *GetType()* method with a FullName property which tells you the name of the type this object was derived from:

```
$date = Get-Date
$date.GetType().FullName

  System.DateTime
```

Every type can have its own set of private members called "static" members. Simply specify a type in square brackets, then pipe it to *Get-Member* and use the *-static* parameter to see the static members of a type.

```
[System.DateTime] | Get-Member -static -memberType *method

  TypeName: System.DateTime
  Name                  MemberType Definition
  ----                  ---------- ----------
  Compare               Method     static System.Int32 Compare(
                                     DateTime t1, DateTime t2)
  DaysInMonth           Method     static System.Int32 DaysInMonth(
                                     Int32 year, Int32 month)
  Equals                Method     static System.Boolean Equals(
                                     DateTime t1, DateTime t2),
                                     static Sys...
  FromBinary            Method     static System.DateTime FromBinary(
                                     Int64 dateData)
  FromFileTime          Method     static System.DateTime
                                     FromFileTime(Int64 fileTime)
  FromFileTimeUtc       Method     static System.DateTime
                                     FromFileTimeUtc(Int64 fileTime)
```

```
FromOADate             Method    static System.DateTime FromOADate(
                                   Double d)
get_Now                Method    static System.DateTime get_Now()
get_Today              Method    static System.DateTime get_Today()
get_UtcNow             Method    static System.DateTime get_UtcNow()
IsLeapYear             Method    static System.Boolean IsLeapYear(
                                   Int32 year)
op_Addition            Method    static System.DateTime
                                   op_Addition(DateTime d,
                                   TimeSpan t)
op_Equality            Method    static System.Boolean
                                   op_Equality(DateTime d1,
                                   DateTime d2)
op_GreaterThan         Method    static System.Boolean
                                   op_GreaterThan(DateTime t1,
                                   DateTime t2)
op_GreaterThanOrEqual Method     static System.Boolean
                                   op_GreaterThanOrEqual(DateTime t1,
                                   DateTime t2)
op_Inequality          Method    static System.Boolean
                                   op_Inequality(DateTime d1,
                                   DateTime d2)
op_LessThan            Method    static System.Boolean
                                   op_LessThan(DateTime t1,
                                   DateTime t2)
op_LessThanOrEqual     Method    static System.Boolean
                                   op_LessThanOrEqual(DateTime t1,
                                   DateTime t2)
op_Subtraction         Method    static System.DateTime
                                   op_Subtraction(DateTime d,
                                   TimeSpan t), sta...
Parse                  Method    static System.DateTime
                                   Parse(String s), static System.
                                   DateTime Par...
ParseExact             Method    static System.DateTime
                                   ParseExact(String s, String
                                   format, IFormat...
ReferenceEquals        Method    static System.Boolean
                                   ReferenceEquals(Object objA,
                                   Object objB)
SpecifyKind            Method    static System.DateTime
                                   SpecifyKind(DateTime value,
                                   DateTimeKind kind)
TryParse               Method    static System.Boolean
                                   TryParse(String s, DateTime&
                                   result), static...
TryParseExact          Method    static System.Boolean
                                   TryParseExact(String s,
                                   String format, IFo...
```

note There are a lot of method names starting with "op_," with "op" standing for "operator." These are methods called internally whenever you use this data type with an operator. *op_GreaterThanOrEqual* is the method that does the internal work when you use the PowerShell comparison operator "-ge" with date values.

The *System.DateTime* class supplies you with a bunch of important date and time methods. For example, to convert a date string into a real DateTime object and use the current locale, use *Parse()*:

```
[System.DateTime]::Parse("March 12, 1999")

  Friday, March 12, 1999 00:00:00
```

You could easily find out whether a certain year is a leap year:

```
[System.DateTime]::isLeapYear(2010)

  False

for ($x=2000; $x -lt 2010; $x++) {
  if( [System.DateTime]::isLeapYear($x) )
    { "$x is a leap year!" } }

  2000 is a leap year!
  2004 is a leap year!
  2008 is a leap year!
```

Or you'd like to tell your children with absolute precision how much time will elapse before they get their Christmas gifts:

```
[DateTime]"12/24/2007 18:00" - [DateTime]::now

  Days              : 74
  Hours             : 6
  Minutes           : 28
  Seconds           : 49
  Milliseconds      : 215
  Ticks             : 64169292156000
  TotalDays         : 74.2700140694444
  TotalHours        : 1782,48033766667
  TotalMinutes      : 106948,82026
  TotalSeconds      : 6416929,2156
  TotalMilliseconds : 6416929215,6
```

Two dates are being subtracted from each other here so you now know what happened during this operation:

- The first time indication is actually text. For it to become a *DateTime* object, you must specify the desired object type in square brackets. *Important: Converting a String to a DateTime this way always uses the US locale. To convert a String to a DateTime using your current locale, use the Parse() method as shown a couple of moments ago!*
- The second time comes from the *Now* static property, which returns the current time as *DateTime* object. This is the same as calling the *Get-Date* cmdlet (which you'd then need to put in parenthesis because you wouldn't want to subtract the *Get-Date* cmdlet but rather the *result* of the *Get-Date* cmdlet).
- The two timestamps are subtracted from each other using the subtraction operator ("-"). This was possible because the *DateTime* class defined the *op_Subtraction()* static method, which is needed for this operator.

Of course, you could have called the static method yourself and received the same result:

```
[DateTime]::op_Subtraction("12/24/2007 18:00", [DateTime]::Now)
```

Now it's your turn. In the *System.Math* class, you'll find a lot of useful mathematical methods. Try to put some of these methods to work.

Function	Description	Example
Abs	Returns the absolute value of a specified number (without signs).	[Math]::Abs(-5)
Acos	Returns the angle whose cosine is the specified number.	[Math]::Acos(0.6)
Asin	Returns the angle whose sine is the specified number.	[Math]::Asin(0.6)
Atan	Returns the angle whose tangent is the specified number.	[Math]::Atan(90)
Atan2	Returns the angle whose tangent is the quotient of two specified numbers.	[Math]::Atan2(90, 15)
BigMul	Calculates the complete product of two 32-bit numbers.	[Math]::BigMul(1gb, 6)
Ceiling	Returns the smallest integer greater than or equal to the specified number.	[Math]::Ceiling(5.7)
Cos	Returns the cosine of the specified angle.	[Math]::Cos(90)

Cosh	Returns the hyperbolic cosine of the specified angle.	[Math]::Cosh(90)
DivRem	Calculates the quotient of two numbers and returns the remainder in an output parameter.	$a = 0 [Math]::DivRem(10,3,[ref]$a) $a
Exp	Returns the specified power of e (2.7182818).	[Math]::Exp(12)
Floor	Returns the largest integer less than or equal to the specified number.	[Math]::Floor(5.7)
IEEERemainder	Returns the remainder of division of two specified numbers.	[Math]::IEEERemainder(5,2)
Log	Returns the natural logarithm of the specified number.	[Math]::Log(1)
Log10	Returns the base 10 logarithm of the specified number.	[Math]::Log10(6)
Max	Returns the larger of two specified numbers.	[Math]::Max(-5, 12)
Min	Returns the smaller of two specified numbers.	[Math]::Min(-5, 12)
Pow	Returns a specified number raised to the specified power.	[Math]::Pow(6,2)
Round	Rounds a value to the nearest integer or to the specified number of decimal places.	[Math]::Round(5.51)
Sign	Returns a value indicating the sign of a number.	[Math]::Sign(-12)
Sin	Returns the sine of the specified angle.	[Math]::Sin(90)
Sinh	Returns the hyperbolic sine of the	[Math]::Sinh(90)

	specified angle.	
Sqrt	Returns the square root of a specified number.	[Math]::Sqrt(64)
Tan	Returns the tangent of the specified angle.	[Math]::Tan(45)
Tanh	Returns the hyperbolic tangent of the specified angle.	[Math]::Tanh(45)
Truncate	Calculates the integral part of a number.	[Math]::Truncate(5.67)

Table 6.5: Mathematical functions from the [Math] library

Finding Interesting .NET Types

The .NET framework consists of thousands of types, and maybe you are getting hungry for more. Are there other interesting types? There are actually plenty! Here are the three things you can do with .NET types:

Converting Object Types

For example, use System.Net.IPAddress to work with IP addresses. This is an example of a .NET type conversion where a string is converted into a *System.Net.IPAddress* type:

```
[system.Net.IPAddress]'127.0.0.1'

  IPAddressToString : 127.0.0.1
  Address           : 16777343
  AddressFamily     : InterNetwork
  ScopeId           :
  IsIPv6Multicast   : False
  IsIPv6LinkLocal   : False
  IsIPv6SiteLocal   : False
```

Using Static Type Members

Or use *System.Net.DNS* to resolve host names. This is an example of accessing a static type method like *GetHostByAddress()*:

```
[system.Net.Dns]::GetHostByAddress("127.0.0.1")

  HostName   Aliases    AddressList
  --------   -------    -----------
  PCNEU01    {}         {127.0.0.1}
```

Using Dynamic Object Instance Members

Or you can derive an instance of a type and use its dynamic members. For example, to download a file from the Internet:

```
# Download address of a file:
$address = "http://powershell.com/cs/media/p/467/download.aspx"
# Save the file to this location:
$target = "$home\chart_drive_space.V2.ps1"
# Carry out download:
$object = New-Object Net.WebClient
$object.DownloadFile($address, $target)
"File was downloaded!"
```

Listing Assemblies

The search for interesting types begins with assemblies as they contain the types. First, you need to get a list of all the assemblies that PowerShell has loaded. Use the AppDomain type to find out the loaded assemblies. Its *CurrentDomain()* static method will give you access to the internal PowerShell .NET framework where you'll find the *GetAssemblies()* dynamic method, which will enable you to get a list of the loaded assemblies:

```
[AppDomain]::CurrentDomain

  FriendlyName           : DefaultDomain
  Id                     : 1
  ApplicationDescription :
  BaseDirectory          : C:\WINDOWS\system32\WindowsPowerShell\v1.0\
  DynamicDirectory       :
  RelativeSearchPath     :
  SetupInformation       : System.AppDomainSetup
  ShadowCopyFiles        : False
  [AppDomain]::CurrentDomain.GetAssemblies()
  GAC    Version        Location
  ---    -------        --------
  True   v2.0.50727     C:\Windows\Microsoft.NET\Framework\
                          v2.0.50727\mscorlib.dll
  True   v2.0.50727     C:\Windows\assembly\GAC_MSIL\Microsoft.
                          PowerShell.ConsoleHost\...
  True   v2.0.50727     C:\Windows\assembly\GAC_MSIL\System\
                          2.0.0.0__b77a5c561934e089\...
  True   v2.0.50727     C:\Windows\assembly\GAC_MSIL\System.
                          Management.Automation\1.0....
```

```
True    v2.0.50727    C:\Windows\assembly\GAC_MSIL\System.
                        Configuration.Install\2.0....
True    v2.0.50727    C:\Windows\assembly\GAC_MSIL\Microsoft.
                        PowerShell.Commands.Man...
True    v2.0.50727    C:\Windows\assembly\GAC_MSIL\Microsoft.
                        PowerShell.Security\1.0...
True    v2.0.50727    C:\Windows\assembly\GAC_MSIL\Microsoft.
                        PowerShell.Commands.Uti...
True    v2.0          C:\Windows\assembly\GAC_MSIL\Microsoft.
                        PowerShell.ConsoleHost....
True    v2.0.50727    C:\Windows\assembly\GAC_32\System.
                        Data\2.0.0.0__b77a5c561934e0...
True    v2.0.50727    C:\Windows\assembly\GAC_MSIL\System.
                        Xml\2.0.0.0__b77a5c561934e...
True    v2.0.50727    C:\Windows\assembly\GAC_MSIL\System.
                        DirectoryServices\2.0.0.0_...
True    v2.0.50727    C:\Windows\assembly\GAC_MSIL\System.
                        Management\2.0.0.0__b03f5f...
True    v2.0          C:\Windows\assembly\GAC_MSIL\System.
                        Management.Automation.reso...
True    v2.0.50727    C:\Windows\Microsoft.NET\Framework\
                        v2.0.50727\mscorlib.dll
True    v2.0          C:\Windows\assembly\GAC_MSIL\Microsoft.
                        PowerShell.Security.res...
True    v2.0          C:\Windows\assembly\GAC_MSIL\Microsoft.
                        PowerShell.Commands.Uti...
True    v2.0.50727    C:\Windows\assembly\GAC_MSIL\System.
                        Configuration\2.0.0.0__b03...
```

tip

You may see more assemblies than listed above. Any PowerShell snap-in loads its own assemblies, and the System.Reflection.Assembly type provides methods to manually load additional assemblies from .NET DLL files or the global assembly cache.

Finding Interesting Classes (Types)

To find out which types are located in an assembly, use the *GetExportedTypes()* method provided by an assembly. Since most assemblies contain way too many types you could search for a specific keyword. This code list all types that include the search word "environment":

```
$searchtext = "*Environment*"
[AppDomain]::CurrentDomain.GetAssemblies() |
  ForEach-Object { $_.GetExportedTypes() } |
  Where-Object { $_ -like $searchtext } |
  ForEach-Object { $_.FullName }

System.EnvironmentVariableTarget
```

```
    System.Environment
    System.Environment+SpecialFolder
    System.Runtime.InteropServices.RuntimeEnvironment
    System.Security.Permissions.EnvironmentPermissionAccess
    System.Security.Permissions.EnvironmentPermission
    System.Security.Permissions.EnvironmentPermissionAttribute
    System.ComponentModel.Design.Data.IDataEnvironment
    Microsoft.PowerShell.Commands.EnvironmentProvider
    System.Web.Configuration.HostingEnvironmentSection
    System.Web.Hosting.HostingEnvironment
```

One of the types that show up is the type System.Environment. The *System.Environment* type can do very useful things. Let's list its static members:

```
  [System.Environment] | Get-Member -static

    TypeName: System.Environment
    Name                        MemberType Definition
    ----                        ---------- ----------
    Exit                        Method     static System.Void
                                             Exit(Int32 exitCode)
    ExpandEnvironmentVariables Method     static System.String
                                             ExpandEnvironmentVariables...
    FailFast                    Method     static System.Void
                                             FailFast(String message)
    GetCommandLineArgs          Method     static System.String[]
                                             GetCommandLineArgs()
    GetEnvironmentVariable      Method     static System.String
                                             GetEnvironmentVariable(...
    GetEnvironmentVariables     Method     static System.Collections.
                                             IDictionary GetEnvironmentV...
    GetFolderPath               Method     static System.String
                                             GetFolderPath(SpecialFolder...
    GetLogicalDrives            Method     static System.String[]
                                             GetLogicalDrives()
    SetEnvironmentVariable      Method     static System.Void
                                             SetEnvironmentVariable(...
    CommandLine                 Property   static System.String
                                             CommandLine {get;}
    CurrentDirectory            Property   static System.String
                                             CurrentDirectory {get;set;}
    ExitCode                    Property   static System.Int32 ExitCode
                                             {get;set;}
    HasShutdownStarted          Property   static System.Boolean
                                             HasShutdownStarted {get;}
    MachineName                 Property   static System.String
                                             MachineName {get;}
    NewLine                     Property   static System.String
                                             NewLine {get;}
    OSVersion                   Property   static System.
                                             OperatingSystem OSVersion
                                             {get;}
     ProcessorCount             Property   static System.Int32
                                             ProcessorCount {get;}
     StackTrace                 Property   static System.String
                                             StackTrace {get;}
     SystemDirectory            Property   static System.String
                                             SystemDirectory {get;}
     TickCount                  Property   static System.Int32
                                             TickCount {get;}
     UserDomainName             Property   static System.String
                                             UserDomainName {get;}
     UserInteractive            Property   static System.Boolean
                                             UserInteractive {get;}
     UserName                   Property   static System.String
                                             UserName {get;}
     Version                    Property   static System.Version
                                             Version {get;}
     WorkingSet                 Property   static System.Int64
                                             WorkingSet {get;}
```

For example, the static methods of the *System.Environment* class will show you which user has executed the script on which machine:

```
[system.Environment]::UserDomainName +
"\" + [System.Environment]::UserName +
" on " + [System.Environment]::MachineName

  Idera\Tobias Weltner on PC12
```

Using *GetFolderPath()*, the class will also reveal the paths to all important Windows folders. To find out the proper values for an argument, specify an invalid argument, and the error message will list all valid argument values:

```
[System.Environment]::GetFolderPath("HH")

  Cannot convert argument "0", with value: "HH", for
  "GetFolderPath" to type "System.Environment+SpecialFolder":
  "Cannot convert value "HH" to type "System.Environment+
  SpecialFolder" due to invalid enumeration values. Specify
  one of the following enumeration values and try again.
  The possible enumeration values are "Desktop, Programs,
  Personal, MyDocuments, Favorites, Startup, Recent, SendTo,
  StartMenu, MyMusic, DesktopDirectory, MyComputer,Templates,
  ApplicationData, LocalApplicationData, InternetCache,
  Cookies, History, CommonApplicationData, System,
  ProgramFiles, MyPictures, CommonProgramFiles"."
```

So, if you'd like to know where the picture folder is on your computer, use *MyPictures*.

```
[System.Environment]::GetFolderPath("MyPictures")

  C:\Users\Tobias Weltner\Pictures
```

Looking for Methods

Next, let's search for some interesting methods. Here's a way for you to find the *GetFolderPath()* method of the previous example:

```
$searchtext = "*getfolder*"
[AppDomain]::CurrentDomain.GetAssemblies() |
  ForEach-Object { $_.GetExportedTypes() } |
  ForEach-Object { $_.getmembers() } |
  Where-Object { $_.isStatic} |
  Where-Object { $_ -like $searchtext } |
  ForEach-Object { "[{0}]::{1} --> {2}" -f `
  $_.declaringtype, $_.toString().SubString( `
  $_.toString().IndexOf(" ")+1), $_.ReturnType }

  [System.Environment]::GetFolderPath(SpecialFolder)
     --> System.String
```

The search can easily take a few minutes because PowerShell examines every single method in every type exposed by every loaded assembly.

Creating New Objects

You have seen that many .NET types contain useful static methods. In addition, you can create new objects (instances) that are derived from a specific type. To create new instances, you can either convert an existing object to a new type, or you can create a new instance using *New-Object*. In addition, you may be able to call some cmdlet or method that happens to return the object type you are after:

```
$datetime = [System.DateTime] '1.1.2000'
$datetime.GetType().Fullname

  System.DateTime

$datetime = New-Object System.DateTime
$datetime.GetType().Fullname

  System.DateTime

$datetime = Get-Date
$datetime.GetType().Fullname

  System.DateTime

$datetime = [System.DateTime]::Parse('1.1.2000')
$datetime.GetType().Fullname

  System.DateTime
```

Creating New Objects with New-Object

You can create a .NET object with *New-Object*, which gives you full access to all type "constructors." These are invisible methods that create the new object. To create a new instance of a type, the type needs to have at least one constructor. If it has none, you cannot create instances of this type.

The DateTime type has one constructor that takes no argument. If you create a new instance of a DateTime object, you get back a date set to the very first date a DateTime type can represent which happens to be January 1, 0001:

```
New-Object System.DateTime

  Monday, January 01, 0001 12:00:00 AM
```

To create a specific date, you would use a different constructor. There is one that takes three numbers for year, month, and day:

```
New-Object System.DateTime(2000,5,1)

  Monday, May 01, 2000 12:00:00 AM
```

If you simply add a number, yet another constructor is used which interprets the number as ticks, the smallest time unit a computer can process:

```
New-Object System.DateTime(568687676789080999)

  Monday, February 07, 1803 7:54:38 AM
```

Using Constructors

When you create a new object using *New-Object*, you can submit additional arguments by adding argument values as a comma separated list enclosed in parentheses. *New-Object* in fact is calling a method called *ctor* which is the type constructor. Like any other method, it can support different argument signatures.

Let's check out how you can discover the different constructors a type supports. The next line creates a new instance of a System.String and uses a constructor that accepts a character and a number:

```
New-Object System.String(".", 100)

  ..................................................
  ..................................................
```

To list the available constructors for a type, use the GetConstructors() method available in each type. For example, you could find out which constructors are offered by the *System.String* type to produce *System.String* objects:

```
[System.String].GetConstructors() |
ForEach-Object { $_.toString() }

  Void .ctor(Char*)
  Void .ctor(Char*, Int32, Int32)
  Void .ctor(SByte*)
  Void .ctor(SByte*, Int32, Int32)
  Void .ctor(SByte*, Int32, Int32,
    System.Text.Encoding)
  Void .ctor(Char[], Int32, Int32)
  Void .ctor(Char[])
  Void .ctor(Char, Int32)
```

In fact, there are eight different signatures to create a new object of the *System.String* type. You just used the last variant: the first argument is the character, and the second a number that specifies how often the character is to be repeated. PowerShell itself uses the next to last constructor so if you specify text in quotation marks, it will interpret text in quotation marks as a field with nothing but characters (*Char[]*).

New Objects by Conversion

Objects can often be created without *New-Object* by using type casting instead. You've already seen how it's done for variables in Chapter 3:

```
# PowerShell normally wraps text as a System.String:
$date = "November 1, 2007"
$date.GetType().FullName

  System.String

$date

  November 1, 2007

# Use strong typing to set the object type of $date:
[System.DateTime]$date = "November 1, 2007"
$date.GetType().FullName

  System.DateTime

$date

  Thursday, November 1, 2007 00:00:00
```

So, if you enclose the desired .NET type in square brackets and put it in front of a variable name, PowerShell will require you to use precisely the specified object type for this variable. If you assign a value to the variable, PowerShell automatically converts it to that type. That process is sometimes called "implicit type conversion." Explicit type conversion works a little different. Here, the desired type is put in square brackets again but placed on the right side of the assignment operator:

```
$value = [DateTime]"November 1, 2007"
```

```
$value

  Thursday, November 1, 2007 00:00:00
```

PowerShell would first convert the text into a date because of the type specification and then assign it to the variable *$value*, which itself remains a regular variable without type specification. Because $value is not limited to DateTime types, you can assign other data types to the variable later on.

```
$value = "McGuffin"
```

Using the type casting, you can also create entirely new objects without *New-Object*. First, create an object using *New-Object*:

```
New-Object system.diagnostics.eventlog("System")

  Max(K) Retain OverflowAction        Entries Name
  ------ ------ --------------        ------- ----
  20,480      0 OverwriteAsNeeded      64,230 System
```

You could have accomplished the same thing without *New-Object*:

```
[System.Diagnostics.EventLog]"System"

  Max(K) Retain OverflowAction        Entries Name
  ------ ------ --------------        ------- ----
  20,480      0 OverwriteAsNeeded      64,230 System
```

In the second example, the string System was converted into the *System.Diagnostics.Eventlog* type: The result is an *EventLog* object representing the *System* event log.

So, when should you use *New-Object* and when type conversion? It is largely a matter of taste, but whenever a type has more than one constructor and you want to select the constructor, use *New-Object* and specify the arguments for the constructor of your choice. Type conversion automatically chooses one constructor, and you have no control over which constructor is picked.

```
# Using New-Object, you can select the
# constructor you wish of the type yourself:
New-Object System.String(".", 100)

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

# When casting types, PowerShell selects the
# constructor automatically. For the System.String
# type, a constructor will be chosen that requires
# no arguments. Your arguments will then be
# interpreted as a PowerShell subexpression in
# which an array will be created. PowerShell will
# change this array into a System.String type.
# PowerShell changes arrays into text by separating
# elements from each other with whitespace:
```

```
[system.string](".",100)

  . 100

# If your arguments are not in round brackets,
# they will be interpreted as an array and the first
# array element cast in the System.String type:
[system.string]".", 100

  .
  100
```

tip

Type conversion can also include type arrays (identified by "[]") and can be a multi-step process where you convert from one type over another type to a final type. This is how you would convert string text into a character array:

```
[char[]]"Hello!"

  H
  e
  l
  l
  o
  !
```

You could then convert each character into integers to get the character codes:

```
[Int[]][Char[]]"Hello World!"

  72
  97
  108
  108
  111
  32
  87
  101
  108
  116
  33
```

Conversely, you could make a numeric list out of a numeric array, and turn that into a string:

```
[string][char[]](65..90)

  A B C D E F G H I J K L M N O P Q R S T U V W X Y Z
```

```
$OFS = ","
[string][char[]](65..90)

  A,B,C,D,E,F,G,H,I,J,K,L,M,N,O,P,Q,R,S,T,U,V,W,X,Y,Z
```

Just remember: if arrays are converted into a string, PowerShell uses the separator in the *$OFS* automatic variable as a separator between the array elements.

Loading Additional Assemblies: Improved Internet Download

To get access to even more functionality, you can load additional assemblies with more types and members. If you have ever written VBScript scripts, you may want to get back some of your beloved VisualBasic methods such as MsgBox() or InputBox(). Simply load the Microsoft.VisualBasic assembly, which is located in the global assembly cache:

```
# Load required assembly:
[void][reflection.assembly]::`
LoadWithPartialName("Microsoft.VisualBasic")
```

Once you did that, you have access to a whole bunch of new types:

```
[Microsoft.VisualBasic.Interaction] | Get-Member -static

  TypeName: Microsoft.VisualBasic.Interaction
  Name            MemberType Definition
  ----            ---------- ----------
  AppActivate     Method     static System.Void
                               AppActivate(Int32 Proces...
  Beep            Method     static System.Void
                               Beep()
  CallByName      Method     static System.Object
                               CallByName(Object Obje...
  Choose          Method     static System.Object
                               Choose(Double Index, P...
  Command         Method     static System.String
                               Command()
  CreateObject    Method     static System.Object
                               CreateObject(String Pr...
  DeleteSetting   Method     static System.Void
                               DeleteSetting(String App...
  Environ         Method     static System.String
                               Environ(Int32 Expressi...
  Equals          Method     static System.Boolean
                               Equals(Object objA, O...
  GetAllSettings  Method     static System.String[,]
                               GetAllSettings(Stri...
  GetObject       Method     static System.Object
                               GetObject(String PathN...
  GetSetting      Method     static System.String
                               GetSetting(String AppN...
  IIf             Method     static System.Object
                               IIf(Boolean Expression...
  InputBox        Method     static System.String
                               InputBox(String Prompt...
  MsgBox          Method     static Microsoft.VisualBasic.
                               MsgBoxResult M...
  Partition       Method     static System.String
                               Partition(Int64 Number...
  ReferenceEquals Method     static System.Boolean
                               ReferenceEquals(Objec...
  SaveSetting     Method     static System.Void
                               SaveSetting(String AppNa...
  Shell           Method     static System.Int32
                               Shell(String PathName, ...
  Switch          Method     static System.Object
                               Switch(Params Object[]...

[microsoft.VisualBasic.Interaction]::`
InputBox("Enter Name", "Name", "$env:username")

  Tobias
```

Or, you could use a much-improved download method, which shows a progress bar while downloading files from the Internet:

```
 # Reload required assembly:
 [void][reflection.assembly]::`
 LoadWithPartialName("Microsoft.VisualBasic")
 # Download address of a file:
 $address = "http://powershell.com/cs/" +
   "media/p/467/download.aspx"
 # This is where the file should be saved:
 $target = "$home\chart_drive_space.V2.ps1"
 # Download will be carried out:
 $object = New-Object `
   Microsoft.VisualBasic.Devices.Network
 $object.DownloadFile(
   $address, $target, "", "",
   $true, 500, $true, "DoNothing")
```

Using COM Objects

In addition to .NET, PowerShell can also load and access COM objects which work similar to .NET types and objects but use an older technology.

Which COM Objects Are Available?

COM objects each have a unique name known as *ProgID* or *Programmatic Identifier*, which is stored in the registry. So, if you want to look up COM objects available on your computer, visit the registry:

```
Dir REGISTRY::HKEY_CLASSES_ROOT\CLSID `
  -include PROGID -recurse |
  foreach {$_.GetValue("")}
```

How Do You Use COM Objects?

Once you know the *ProgID* of a COM component, use *New-Object* to put it to work in PowerShell. Just specify the additional parameter *-comObject*:

```
$object = New-Object -comObject WScript.Shell
```

You'll get an object which behaves very similar to .NET objects. It will contain properties with data and methods that you can execute. And, as always, *Get-Member* finds all object members for you. Let's look at its methods:

```
# Make the methods of the COM objects visible:
$object | Get-Member -memberType *method

   TypeName: System.__ComObject#{41904400-be18-
     11d3-a28b-00104bd35090}
   Name            MemberType Definition
   ----            ---------- ----------
   AppActivate     Method     bool AppActivate (Variant, Variant)
   CreateShortcut  Method     IDispatch CreateShortcut (string)
   Exec            Method     IWshExec Exec (string)
   ExpandEnviron   Method     string ExpandEnvironmentStrings
     mentStrings                (string)
   LogEvent        Method     bool LogEvent (Variant, string,
                                string)
   Popup           Method     int Popup (string, Variant,
                                Variant, Variant)
   RegDelete       Method     void RegDelete (string)
   RegRead         Method     Variant RegRead (string)
   RegWrite        Method     void RegWrite (string, Variant,
                                Variant)
   Run             Method     int Run (string, Variant, Variant)
   SendKeys        Method     void SendKeys (string, Variant)
```

The information required to understand how to use a method can be inadequate. Only the expected object types are given, but not why the arguments exist. If you want to know more about a COM command, the Internet can help you. Go to a search site of your choice and enter two keywords: the *ProgID* of the COM components (in this case, it will be *WScript.Shell*) and the name of the method that you want to use.

Some of the commonly used COM objects are WScript.Shell, WScript.Network, Scripting.FileSystemObject, InternetExplorer.Application, Word.Application, and Shell.Application. Let's create a shortcut to powershell.exe using WScript.Shell Com object and its method CreateShorcut():

```
# Create an object:
$wshell = New-Object -comObject WScript.Shell
# Assign a path to Desktop to the variable $path
$path = [system.Environment]::GetFolderPath('Desktop')
# Create a link object
$link = $wshell.CreateShortcut("$path\PowerShell.lnk")
# $link is an object and has the properties and methods
$link | Get-Member

  TypeName: System.__ComObject#{f935dc23-1cf0-11d0-adb9-00c04fd58a0b}
  Name             MemberType   Definition
  ----             ----------   ----------
  Load             Method       void Load (string)
  Save             Method       void Save ()
  Arguments        Property     string Arguments () {get} {set}
  Description      Property     string Description () {get} {set}
  FullName         Property     string FullName () {get}
  Hotkey           Property     string Hotkey () {get} {set}
  IconLocation     Property     string IconLocation () {get} {set}
  RelativePath     Property      {get} {set}
  TargetPath       Property     string TargetPath () {get} {set}
  WindowStyle      Property     int WindowStyle () {get} {set}
  WorkingDirectory Property     string WorkingDirectory () {get} {set}

# We can populate some of the properties
$link.TargetPath = 'powershell.exe'
$link.Description = 'Launch Windows PowerShell console'
$link.WorkingDirectory = $profile
$link.IconLocation = 'powershell.exe'
# And save the changes using Save() method
$link.Save()
```

Summary

Everything in PowerShell is represented by objects that have exactly two aspects: properties and methods, which both form the members of the object. While properties store data, methods are executable commands.

Objects are the result of all PowerShell commands and are not converted to readable text until you output the objects to the console. However if you save a command's result in a variable, you will get a handle on the original objects and be able to evaluate their properties or call their commands. If you would like to see all of an object's properties, then pass the object to *Format-List* and type an asterisk after it. In this way, all—and not only the most important—properties will be output as text.

The *Get-Member* cmdlet retrieves even more data, enabling you to output detailed information on the properties and methods of any object.

All the objects with which you work in PowerShell originate from .NET framework, on which PowerShell is layered. Aside from the objects that PowerShell commands provide you as results, you can also invoke objects directly from the .NET framework and gain access to a powerful arsenal of new commands. Along with the dynamic methods furnished by objects, there are also static methods, which are provided directly by the class from which objects are also derived.

If you cannot perform a task either with the cmdlets, regular console commands, or methods of the .NET framework, you can resort to the unmanaged world outside the .NET framework. Either directly access the low-level API functions, the foundation of the .NET framework, or use COM components.

CHAPTER 7.

Conditions

You'll need a condition first to compose intelligent PowerShell code capable of making decisions. That's why you'll learn in the first part of this Chapter how to formulate questions as conditions.

In the second part, you'll employ conditions to execute PowerShell instructions only if a particular condition is actually met.

Topics Covered:

Formulating Conditions

A condition is nothing more than a question that can be answered clearly in the positive (*true*) or in the negative (*false*). Nearly all questions are phrased with the help of comparisons. The following PowerShell comparison operators allow you to compare values:

Operator	Conventional	Description	Example	Result
-eq, -ceq, -ieq	=	equals	10 -eq 15	$false

-ne, -cne, -ine	<>	not equal	10 -ne 15	$true
-gt, -cgt, -igt	>	greater than	10 -gt 15	$false
-ge, -cge, -ige	>=	greater than or equal to	10 -ge 15	$false
-lt, -clt, -ilt	<	less than	10 -lt 15	$true
-le, -cle, -ile	<=	less than or equal to	10 -le 15	$true
-contains, -ccontains, -icontains		contains	1,2,3 -contains 1	$true
-notcontains, -cnotcontains, -inotcontains		does not contain	1,2,3 -notcontains 1	$false

Table 7.1: Comparison operators

note

PowerShell doesn't use the traditional comparison operators that you may know from other programming languages. In particular, the "=" operator is purely an assignment operator in PowerShell, while ">" and "<" operators are used for redirection.

There are three variants of all comparison operators. The basic variant is case-insensitive when making comparisons. If you'd like to explicitly specify whether case sensitivity should be taken into account, use variants that begin with "c" (case-sensitive) or "i" (case-insensitive).

Carrying Out a Comparison

You can carry out comparisons immediately and directly in the PowerShell console. First, enter a value, then a comparison operator, and then the second value that you want to compare with the first. As soon as you hit (enter), the comparison will be performed. The result should always be *True* (condition is correct) or *False* (condition is incorrect).

```
4 -eq 10
```

```
  False
```

```
"secret" -ieq "SECRET"

  True
```

As long as you compare only numbers or only strings, comparisons are very easy to grasp and return exactly the result that you expect:

```
123 -lt 123.5

  True
```

However, you can also compare different data types. These results are not always as logical as the previous one:

```
12 -eq "Hello"

  False

12 -eq "000012"

  True

"12" -eq 12

  True

"12" -eq 012

  True

"012" -eq 012

  False

123 -lt 123.4

  True

123 -lt "123.4"

  False

123 -lt "123.5"

  True
```

Would you have expected these results? Some comparisons return peculiar results. That's precisely what happens when you compare *different* data types, and the reason is that PowerShell actually cannot compare different data types at all. PowerShell tries to convert the data types into a common data type that can be compared. However, this automatic conversion doesn't always return the result that you would intuitively expect, so you should avoid comparisons of differing data types.

"Reversing" Comparisons

A comparison always returns a result that is either *true* or *false*, and you've seen that there are complementary comparison operators for most comparisons: *-eq* and *-ne* (equal and not equal) or -*gt* and *-lt* (greater than and less than).

In addition, with the logical operator -not you have the option of "reversing" the result of a comparison. It expects an expression on the right side that is either *true* or *false*, and it turns this around. Instead of -not, you may also use the abbreviated "!":

```
$a = 10
$a -gt 5

  True

-not ($a -gt 5)

  False

# Shorthand: instead of -not "!" can also be used:
!($a -gt 5)

  False
```

note

Make generous use of parentheses if you're working with logical operators like *-not*. Logical operators are always interested in the result of a comparison, but not in the comparison itself. That's why the comparison should always be in parentheses.

Combining Comparisons

Because every comparison returns either *True* or *False*, you can combine several comparisons with logical operators. The following conditional statement would evaluate to true only if both comparisons evaluate to *true*:

```
( ($age -ge 18) -and ($sex -eq "m") )
```

Put separate comparisons in parentheses because you only want to link the results of these comparisons, certainly not the comparisons themselves.

Operator	Description	Left Value	Right Value	Result
-and	Both conditions must be met	True False False True	False True False True	False False False True
-or	At least one of the two conditions must be met	True False False True	False True False True	True True False True
-xor	One or the other condition must be met, but not both	True False False True	True False True False	False False True True
-not	Reverses the result	(not applicable)	True False	False True

Table 7.2: Logical operators

Comparisons with Arrays and Collections

Up to now, you've only used the comparison operators in Table 7.1 to compare single values. In Chapter 4, you've already become familiar with arrays. The question is: how do comparison operators react to arrays? To which element of an array is the comparison applied? The simple answer: to all of them.

But the result is not a long list of *True* and *False*. In this case, comparison operators return an array in which precisely those elements of the initial array reappear in the matched comparison—resembling a sort of filter. In the simplest case, use the comparison operator *-eq* (*equal*) to find all elements in an array equal to the specified value:

```
1,2,3,4,3,2,1 -eq 3

  3
  3
```

Two elements having the value of 3 are in the initial array. Only these two elements were returned. It works conversely, too: if you'd like to see only the elements of an array that don't match the comparison value, use *-ne* (*not equal*) operator:

```
1,2,3,4,3,2,1 -ne 3
```

```
    1
    2
    4
    2
    1
```

Verifying Whether an Array Contains a Particular Element

How can you find out whether an array contains a particular element? As you have seen, -eq provides no answer to this question. That's why there are the comparison operators *-contains* and *-notcontains*. They verify whether a certain value exists in an array.

```
# -eq returns only those elements matching the criterion:
1,2,3 -eq 5

# -contains answers the question of whether the sought element is included in the
array:
1,2,3 -contains 5

  False

1,2,3 -notcontains 5

  True
```

Where-Object

Let's now apply conditions in real life. The first area of application is the PowerShell pipeline, which you became acquainted with in Chapter 5. In the pipeline, the results of a command are forwarded directly to the next one, and the *Where-Object* cmdlet works like a filter, allowing only those objects through the pipeline that meet a certain condition. To make this work, specify your condition to *Where-Object*.

Filtering Results in the Pipeline

The cmdlet *Get-Process*, will return all running processes. However, you are not likely to be interested in all processes, but instead you want an answer to a specific problem. For instance, you would like to find out currently running instances of the Notepad. First, get an initial overview of which properties the processes contain by using *Get-Process*. That's important, because you'll use these properties afterwards as the basis for your condition. This is how you can find the available properties:

```
Get-Process | Select-Object -first 1 | Format-List *

  __NounName                 : Process
  Name                       : agrsmsvc
  Handles                    : 36
```

```
VM                         : 21884928
WS                         : 57344
PM                         : 716800
NPM                        : 1768
Path                       :
Company                    :
CPU                        :
FileVersion                :
ProductVersion             :
Description                :
Product                    :
Id                         : 1316
PriorityClass              :
HandleCount                : 36
WorkingSet                 : 57344
PagedMemorySize            : 716800
PrivateMemorySize          : 716800
VirtualMemorySize          : 21884928
TotalProcessorTime         :
BasePriority               : 8
ExitCode                   :
HasExited                  :
ExitTime                   :
Handle                     :
MachineName                : .
MainWindowHandle           : 0
MainWindowTitle            :
MainModule                 :
MaxWorkingSet              :
MinWorkingSet              :
Modules                    :
NonpagedSystemMemorySize   : 1768
NonpagedSystemMemorySize64 : 1768
PagedMemorySize64          : 716800
PagedSystemMemorySize      : 24860
PagedSystemMemorySize64    : 24860
PeakPagedMemorySize        : 716800
PeakPagedMemorySize64      : 716800
PeakWorkingSet             : 2387968
PeakWorkingSet64           : 2387968
PeakVirtualMemorySize      : 21884928
PeakVirtualMemorySize64    : 21884928
PriorityBoostEnabled       :
PrivateMemorySize64        : 716800
PrivilegedProcessorTime    :
ProcessName                : agrsmsvc
ProcessorAffinity          :
Responding                 : True
SessionId                  : 0
StartInfo                  : System.Diagnostics.ProcessStartInfo
StartTime                  :
SynchronizingObject        :
Threads                    : {1964, 1000}
```

```
    UserProcessorTime          :
    VirtualMemorySize64        : 21884928
    EnableRaisingEvents        : False
    StandardInput              :
    StandardOutput             :
    StandardError              :
    WorkingSet64               : 57344
    Site                       :
    Container                  :
```

Formulating a Condition

The name of a process can be found in the *Name* property. If you're just looking for the processes of the Notepad, your condition should be *name -eq 'notepad'*. Now, supply this condition to *Where-Object*:

```
  Get-Process | Where-Object { $_.name -eq 'notepad' }

    Handles  NPM(K)  PM(K)  WS(K)  VM(M)  CPU(s)    Id ProcessName
    -------  ------  -----  -----  -----  ------    -- -----------
         68       4   1636   8744     62    0,14  7732 notepad
         68       4   1632   8764     62    0,05  7812 notepad
```

The pipeline now returns only those processes that meet your condition. If you're not currently running the Notepad, nothing will be returned. If you take a closer look at *Where-Object*, you'll see that your condition is specified in braces after the cmdlet. The *$_* variable contains the current pipeline object.

The next one-liner would retrieve all processes whose company name begins with "Micro" and output for each process its name, description, and company name:

```
  Get-Process | Where-Object { $_.company -like 'micro*' } |
    Format-Table name, description, company

    Name           Description                 Company
    ----           -----------                 -------
    conime         Console IME                 Microsoft Corporation
    dwm            Desktopwindow-Manager       Microsoft Corporation
    ehmsas         Media Center Media Statu... Microsoft Corporation
    ehtray         Media Center Tray Applet    Microsoft Corporation
    EXCEL          Microsoft Office Excel      Microsoft Corporation
    explorer       Windows-Explorer            Microsoft Corporation
    GrooveMonitor  GrooveMonitor Utility       Microsoft Corporation
    ieuser         Internet Explorer           Microsoft Corporation
    iexplore       Internet Explorer           Microsoft Corporation
    msnmsgr        Messenger                   Microsoft Corporation
    notepad        Editor                      Microsoft Corporation
    notepad        Editor                      Microsoft Corporation
    sidebar        Windows-Sidebar             Microsoft Corporation
    taskeng        Task Scheduler Engine       Microsoft Corporation
    WINWORD        Microsoft Office Word       Microsoft Corporation
```

```
wmpnscfg        Windows Media Player Net... Microsoft Corporation
wpcumi          Windows Parental Control... Microsoft Corporation
```

tip

In Chapter 6 you learned that every single process in this list is actually an object that not only has the properties that you just made visible in the previous example, but also has methods. That means you could go on to process the result of your condition object by object and, in doing so, invoke methods for every object. To do so, you need loops, which will be explained in more detail in the next Chapter. However, for the time being, here's a little preview: the next line ends all Notepad processes. Watch out: the processes will be ended immediately and without request for confirmation. All data that you haven't saved will be lost:

```
# Attention: all instances of Notepad will be terminated
# immediately and without further notification:
Get-Process | Where-Object { $_.name -eq 'notepad' } |
  Foreach-Object { $_.Kill() }
```

Using Alias

Because you often need conditions in the pipeline, an alias exists for *Where-Object*: "?". So, instead of *Where-Object*, you may also use "?'".

```
# The two following instructions return the same result:
# all running services
Get-Service | ForEach-Object {$_.Status -eq 'Running' }
Get-Service | ? {$_.Status -eq 'Running' }
```

If-ElseIf-Else

Where-object works splendidly in the pipeline, but it is inappropriate if you want to make longer code segments dependent on meeting a condition. Here, the *If..ElseIf..Else* statement works much better. In the simplest case, the statement looks like this:

```
If (condition) {
  # If the condition applies,
  # this code will be executed
}
```

The condition must be enclosed in parentheses and follow the keyword *If*. If the condition is met, the code in the braces after it will be executed, otherwise not. Try it out:

If ($a -gt 10) { "$a is larger than 10" }

It's likely, though, that you won't (yet) see a result. The condition was not met, and so the code in the braces wasn't executed. To get an answer, make sure that the condition is met:

```
$a = 11
If ($a -gt 10) { "$a is larger than 10" }

  11 is larger than 10
```

Now the comparison is correct, and the *If* statement ensures that the code in the braces returns a result. As it is, that clearly shows that the simplest *If* statement usually doesn't suffice in itself, because you would like to *always* get a result, even when the condition isn't met. To accomplish that, expand the *If* statement with *Else*:

```
If ($a -gt 10)
{
  "$a is larger than 10"
}
Else
{
  "$a is less than or equal to 10"
}
```

Now the code in the braces after *If* is executed if the condition is met; if the preceding condition isn't true, the code in the braces after *Else is executed*. If you have several conditions you may insert as many *ElseIf* blocks between *If* and *Else* as you like:

```
If ($a -gt 10)
{
  "$a is larger than 10"
}
ElseIf ($a -eq 10)
{
  "$a is exactly 10"
}
Else
{
  "$a is less than 10"
}
```

The *If* statement here always executes the code in the braces after the condition that is met. The code after *Else will* be executed when none of the preceding conditions are true. What happens if several conditions are true? Then the code after the first applicable condition will be executed and all other applicable conditions will be ignored.

```
If ($a -gt 10)
{
  "$a is larger than 10"
}
ElseIf ($a -eq 10)
{
  "$a is exactly 10"
}
```

```
ElseIf ($a -ge 10)
{
  "$a is larger than or equal to 10"
}
Else
{
  "$a is smaller than 10"
}
```

note The fact is that the *If* statement doesn't care at all about the condition that you state. All that the *If* statement evaluates is *$true* or *$false*. If condition evaluates *$true*, the code in the braces after it will be executed, otherwise not. Conditions are only a way to return one of the requested values *$true* or *$false*. But the value could come from another function or from a variable:

```
# Returns True from 14:00 on, otherwise False:
Function isAfternoon { (Get-Date).Hour -gt 13 }
isAfternoon

  True

# Result of the function determines which code the If statement
executes:
If (isAfternoon) { "Time for break!" } Else { "It's still early." }

  Time for break!
```

The example shows that the condition after *If* must always be in parentheses, but it can also come from any source as long as it is *$true* or *$false*. In addition, you may also write the *If* statement in a single line. If you'd like to execute more than one command in the braces without having to use new lines, separate the commands with a semicolon ";".

Switch

If you'd like to test a value against many comparison values, the *If* statement could quickly become confusing. The *Switch* statement is much clearer and quicker:

```
# Test a value against several comparison values (with If statement):
$value = 1
If ($value -eq 1)
{
  " Number 1"
}
ElseIf ($value -eq 2)
{
  " Number 2"
}
ElseIf ($value -eq 3)
{
  " Number 3"
}

  Number 1

# Test a value against several comparison values (with Switch statement):
$value = 1
Switch ($value)
{
  1  { "Number 1" }
  2  { "Number 2" }
  3  { "Number 3" }
}

  Number 1
```

This is how to use the *Switch statement*: the value to switch on is in the parentheses after the *Switch keyword*. That value is matched with each of the conditions case by case. If a match is found, the action associated with that condition is performed. Default comparison operator is the *-eq* operator to verify equality.

Testing Range of Values

The default comparison operator is *-eq* operator, but you could also compare a value with your own conditions. Formulate your own condition and put it in braces. Condition must result in either *true* or *false*:

```
$value = 8
Switch ($value)
{
  # Instead of a standard value, a code block is used
  # that results in True for numbers smaller than 5:
  {$__-le 5}  { "Number from 1 to 5" }
  # A value is used here; Switch checks whether this
  # value matches $value:
  6  { "Number 6" }
  # Complex conditions are allowed as they are here,
  # where -and is used to combine two comparisons:
  {(($__-gt 6) -and ($__-le 10))} { "Number from 7 to 10" }
}

  Number from 7 to 10
```

- The code block *{$_ -le 5}* includes all numbers less than or equal to 5.

- The code block *{(($_ -gt 6) -and ($_ -le 10))}* combines two conditions and results in *true* if the number is either larger than 6 or less than-equal to 10. Consequently, you may combine any PowerShell statements in the code block and also use the logical operators listed in Table 7.2.

Here, you used the initial value stored in *$_* for your conditions, but because *$_* is generally available anywhere in the *Switch* block, you could just as well have put it to work in the result code:

```
$value = 8
Switch ($value)
{
  # The initial value (here it is in $value)
  # is available in the variable $_:
  {$_ -le 5}  { "$_ is a number from 1 to 5" }
  6  { "Number 6" }
  {(($_ -gt 6) -and ($_ -le 10))}
    { "$_ is a number from 7 to 10" }
}

  8 is a number from 7 to 10
```

No Applicable Condition

In a similar manner as an *If* statement, the *Switch* statement executes code only if at least one of the specified conditions is met. The keyword, which for the *If* statement is called *Else*, is called *default* for *Switch* statement. When no other condition matches, the default clause is run.

```
$value = 50
Switch ($value)
{
  {$_ -le 5}  { "$_is a number from 1 to 5" }
  6  { "Number 6" }
  {(($_ -gt 6) -and ($_ -le 10))}
    { "$_ is a number from 7 to 10" }
  # The code after the next statement will be
  # executed if no other condition has been met:
  default {"$_ is a number outside the range from 1 to 10" }
}

  50 is a number outside the range from 1 to 10
```

Several Applicable Conditions

If more than one condition applies, then *Switch* will behave differently than *If*. For *If*, only the first applicable condition was executed. For *Switch*, all applicable conditions are executed:

```
$value = 50
Switch ($value)
{
  50  { "the number 50" }
  {$_ -gt 10}  {"larger than 10"}
  {$_ -is [int]}  {"Integer number"}
}

  The Number 50
  Larger than 10
  Integer number
```

Consequently, all applicable conditions ensure that the following code is executed, and so in some circumstances you may get more than one result.

tip

Try out that example, but assign 50.0 to *$value*. In this case, you'll get just two results instead of three. Do you have any idea why? That's right: the third condition is no longer fulfilled because the number in *$value* is no longer an integer number. The other two conditions, however, remain fulfilled.

If you'd like to receive only one result, while consequently making sure that only the first applicable condition is performed, then append the *break* statement to the code.

```
  $value = 50
  Switch ($value)
  {
    50  { "the number 50"; break }
    {$_ -gt 10}  {"larger than 10"; break}
    {$_ -is [int]}  {"Integer number"; break}
  }

    The number 50
```

In fact, now you get only the first applicable result. The keyword *break* indicates that no more processing will occur and the *Switch* statement will exit.

Using String Comparisons

The previous examples have always compared numbers. You could also naturally compare strings since you now know that behind the scenes *Switch* uses only the normal *-eq* comparison operator and that there string comparisons are also permitted. The following code could be the basic structure of a command evaluation. A different action will be performed, depending on the specified command:

```
  $action = "sAVe"
  Switch ($action)
  {
    "save"  { "I save..." }
    "open"  { "I open..." }
    "print"  { "I print..." }
    Default  { "Unknown command" }
  }

    I save...
```

Case Sensitivity

Since the *-eq* comparison operator doesn't distinguish between lower and upper case, case sensitivity doesn't play any role in comparisons. If you want to distinguish between them, then use the *-case* option. Working behind the scene, it will replace the *-eq* comparison operator with *-ceq*, after which case sensitivity will suddenly become crucial:

```
  $action = "sAVe"
  Switch -case ($action)
  {
    "save"  { "I save..." }
    "open"  { "I open..." }
    "print"  { "I print..." }
    Default  { "Unknown command" }
  }

    Unknown command
```

Wildcard Characters

In fact, you can also exchange a standard comparison operator for *-like* and *-match* operators and then carry out wildcard comparisons. Using the *-wildcard* option, activate the *-like* operator, which is conversant, among others, with the "*" wildcard character:

```
  $text = "IP address: 10.10.10.10"
  Switch -wildcard ($text)
  {
    "IP*"  { "The text begins with IP: $_" }
    "*.*.*.*"  { "The text contains an IP " +
                 "address string pattern: $_" }
    "*dress*"  { "The text contains the string " +
                 "'dress' in arbitrary locations: $_" }
  }

    The text begins with IP: IP address: 10.10.10.10
    The text contains an IP address string pattern:
      IP address: 10.10.10.10
    The text contains the string 'dress' in arbitrary
      locations: IP address: 10.10.10.10
```

Regular Expressions

Simple wildcard characters can't always be used for recognizing patterns. Regular expressions are much more efficient. But they assume much more basic knowledge, a reason for you to now take a peek ahead at Chapter 13, which discusses regular expression in greater detail.

With the *-regex* option, you can ensure that *Switch* uses the *-match* comparison operator instead of *-eq*, and thus employs regular expressions. Using regular expressions, you can identify a pattern much more precisely than by using simple wildcard characters. But that's not all: as was the case with the *-match* operator, you will usually get back the text that matches the pattern in the *$matches* variable. This way, you could even parse information out of the text:

```
$text = "IP address: 10.10.10.10"
Switch -regex ($text)
{
  "^IP"  { "The text begins with IP: " +
    "$($matches[0])" }
  "\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}" {
    "The text contains an IP address " +
    "string pattern: $($matches[0])" }
  "\b.*?dress.*?\b"  { " The text " +
    "contains the string 'dress' in " +
    "arbitrary locations: $($matches[0])" }
}
```

```
  The text begins with IP: IP
  The text contains an IP address string
    pattern: 10.10.10.10
  The text contains the string 'dress' in
    arbitrary locations: IP address
```

note

The result of the *-match* comparison with the regular expression is returned in *$matches*, a hash table with each result, because regular expressions can, depending on their form, return several results. In the example, only the first result should interest you, the one you got by using *$matches[0]*. To ensure that this result appears in the output text, the entire expression is embedded in *$(...)*.

Processing Several Values Simultaneously

Until now, you have always passed to *Switch* just one value for evaluation. But *Switch* can also process several values at the same time. To do so, pass to *Switch* the values in an array or a collection. In the following example, *Switch* is passed an array containing five elements. *Switch* automatically takes all the elements one at a time from the array and compares each of them, one by one:

```
$array = 1..5
```

```
Switch ($array)
{
  {$_ % 2} { "$_ is odd."}
  Default { "$_ is even."}
}

  1 is odd.
  2 is even.
  3 is odd.
  4 is even.
  5 is odd.
```

There you have it: *Switch* accepts not only single values but also entire arrays and collections. As such, *Switch* would actually be an ideal candidate for evaluating results on the PowerShell pipeline because the pipeline character ("|") is used to forward results as arrays or collections from one command to the next.

The next line queries *Get-Process* for all running processes and pipes the result to a script block (*& {...}*). In the script block, *Switch* evaluates the result of the pipeline, which is available in *$input*. If the *WS* property of a process is larger than one megabyte, this process is output *Switch* will filter all the processes whose WS property is less than or equal to one megabyte:

```
Get-Process | & { Switch($input) { {$_.WS -gt 1MB} { $_ }}}
```

However, this line is extremely hard to read and seems complicated. By using *Where-Object*, you can formulate the condition in a much clearer way:

```
Get-Process | Where-Object { $_.WS -gt 1MB }
```

This variant is also quicker because *Switch* had to wait until the pipeline had collected the entire results of the preceding command in *$input*. In *Where-Object*, it processes the results of the preceding command precisely when the results are ready. This difference is especially striking for elaborate commands:

```
# Switch returns all files beginning with "a":
Dir | & { Switch($input) {
  {$_.name.StartsWith("a")} { $_ } }}
# But it doesn't do so until Dir has retrieved
# all data, and that can take a long time:
Dir -Recurse | & { Switch($input) {
  {$_.name.StartsWith("a")} { $_ } }}
# Where-Object processes the incoming results
# immediately:
Dir -recurse | Where-Object {
  $_.name.StartsWith("a") }
# The alias of Where-Object ("?") works
# exactly the same way:
Dir -recurse | ? { $_.name.StartsWith("a") }
```

Summary

Intelligent decisions are based on conditions, which in the simplest form can be reduced to plain *Yes* or *No* answers. Using the comparison operators listed in Table 7.1, you can formulate such conditions and can even combine these with the logical operators listed in Table 7.2 to form complex queries.

The simple Yes/No answers of your conditions determine whether particular PowerShell instructions should be carried out or not. In the simplest form, you can use the Where-Object cmdlet in the pipeline. It functions there like a filter, allowing only those results through the pipeline that correspond to your condition.

If you would like more control, or would like to execute larger code segments independently of conditions, use the *If* statement, which evaluates as many different conditions as you wish and, depending on the result, executes the allocated code. This is the typical "If-Then" scenario: *if* certain conditions are met, *then* certain code segments will be executed.

An alternative to the *If* statement is the *Switch* statement: using it, you can compare a fixed initial value with various possibilities. *Switch* is the right choice when you want to check a particular variable against many different possible values.

CHAPTER 8.

Loops

Loops are a good example that iterations do not have to be boring. They repeat particular PowerShell statements with the pipeline being one of the areas where you can benefit from loops. Most PowerShell commands wrap their results in arrays, and you'll need a loop when you want to examine single elements in an array more closely.

Topics Covered:

ForEach-Object

The PowerShell pipeline works like an assembly line. Each command is tied to the next and hands over its result to the following command, pretty much like assembly line robots. So, the results from the initial command will be processed by all other commands in real time. If you'd like to look more closely at these objects, you'll need the *ForEach-Object* cmdlet. It executes the code that you specify after it for every object that is guided through the pipeline. This is one of the most important ways to acquire native PowerShell objects. At the same time, it's the simplest form of a loop.

Evaluating Pipeline Objects Separately

If you use *Get-WmiObject* to retrieve all information about all running services, *Get-WmiObject* will acquire the services as objects and direct them through the pipeline. Normally, PowerShell converts these objects into text when they reach the end of the pipeline; at most, you could format the output by using the formatting cmdlets described in Chapter 5:

```
Get-WmiObject Win32_Service |
  Format-Table Name, StartMode, PathName

  Name                        StartMode PathName
  ----                        --------- --------
  AeLookupSvc                 Auto      C:\Windows\system32\
                                          svchost.ex...
  AgereModemAudio             Auto      C:\Windows\system32\
                                          agrsmsvc.exe
  ALG                         Manual    C:\Windows\System32\
                                          alg.exe
  Appinfo                     Manual    C:\Windows\system32\
                                          svchost.ex...
  AppMgmt                     Manual    C:\Windows\system32\
                                          svchost.ex...
  Ati External Event Utility Auto      C:\Windows\system32\
                                          Ati2evxx.exe
  AudioEndpointBuilder        Auto      C:\Windows\System32\
                                          svchost.ex...
  Audiosrv                    Auto      C:\Windows\System32\
                                          svchost.ex...
  Automatic LiveUpdate...     Auto      "C:\Program Files\
                                          Symantec\Liv...
  (...)
```

ForEach-Object gives you more options. It enables you to access all the properties and methods of each object. The ForEach-Object cmdlet executes a block of statements for every single object in a pipeline. Automatic variable $_ contains the current pipeline object.

```
Get-WmiObject Win32_Service |
  ForEach-Object { "{0} ({1}): Path: {2}" `
  -f $_.Name, $_.StartMode, $_.PathName }

  AeLookupSvc (Auto): Path: C:\Windows\system32\svchost.exe -k netsvcs
  AgereModemAudio (Auto): Path: C:\Windows\system32\agrsmsvc.exe
  ALG (Manual): Path: C:\Windows\System32\alg.exe
  Appinfo (Manual): Path: C:\Windows\system32\svchost.exe -k netsvcs
  AppMgmt (Manual): Path: C:\Windows\system32\svchost.exe -k netsvcs
  (...)
```

Integrating Conditions

In the script block after *ForEach-Object*, all PowerShell commands and statements are permitted, so you could output only running services along with their descriptions:

```
Get-WmiObject Win32_Service |
  ForEach-Object {
    if ($_.Started) {
      "{0}({1}) = {2}" -f $_.Caption, $_.Name, $_.Description
    }
  }
```

```
Windows Audio Endpoint Builder = Manages audio devices
for the Windows Audio service. If this service is stopped,
audio devices and effects will not function properly. If
this service is disabled, any services that explicitly
depend on it will no longer start.
Windows-Audio(Audiosrv) = Manages audio devices for
Windows-based programs. If this service is stopped, audio
devices and effects will not function properly. If this
service is disabled, any services that explicitly depend
on it will fail to start.
Base Filtering Engine (BFE) = The Base Filtering Engine
is a service that manages firewall and Internet Protocol
security (Ipsec) policies and implements user mode
filtering.  Stopping or disabling the BFE service will
significantly reduce the security of the system. It will
also result in unpredictable behavior in IPsec management
and firewall applications.
```

tip

Remember the building-block principle of the pipeline and keep it simple and modular! Although it is permitted to specify conditions and complex instructions in the script block after *ForEach-Object*, the pipeline will be easier to read and more flexible if you sub-divide each task into separate steps and use the *Where-Object* cmdlet described in Chapter 7 as a condition:

```
Get-WmiObject Win32_Service |
  Where-Object { $_.Started -eq $true } |
  ForEach-Object {"{0}({1}) = {2}" -f `
  $_.Caption, $_.Name, $_.Description}
```

Don't forget the conditions covered in Chapter 7: they must result in *$true* or *$false*—that's the only requirement. If a variable already contains *$true* or *$false*, its result can be used immediately. So, it doesn't matter at all whether you formulate *$_.Started -eq $true* as a condition or the shorter *$_.Started*, because in either case, the result will be either *$true* or *$false*.

Because the *Where-Object* and *ForEach-Object* building blocks are often used in practice, you can use aliases: "?" stands for *Where-Object* and "%" stands for *ForEach-Object*. This won't make the lines more readable, but they'll be shorter and easier to enter:

```
Get-WmiObject Win32_Service | ? { $_.Started } | % {
  "{0}({1}) = {2}"-f $_.Caption, $_.Name, $_.Description }
```

Invoking Methods

Because *ForEach-Object* gives you access to each object in a pipeline, you can invoke the methods of these objects. In Chapter 7, you already learned how to take advantage of this to close all instances of the Notepad.

```
Get-Process notepad | ForEach-Object { $_.Kill() }
```

However, this instruction closes all processes called *notepad*, even the Notepads that you had opened much earlier. Because PowerShell always works with objects, and because you have access to all object properties and methods within the scope of the *ForEach-Object* cmdlet, you could select just some of them. For example, you could stop only those Notepad processes that haven't been running for longer than three minutes. How can you find out how long a process has already been running?

```
Notepad
$process = @(Get-Process notepad)[0]
$process.StartTime

  Sunday, March 8, 2009 08:17:27
```

The time difference between the current and the start time is calculated by the *New-TimeSpan* cmdlet:

```
New-TimeSpan $process.StartTime (Get-Date)

  Days              : 0
  Hours             : 0
  Minutes           : 3
  Seconds           : 7
  Milliseconds      : 766
  Ticks             : 1877660000
  TotalDays         : 0,00217321759259259
  TotalHours        : 0,0521572222222222
  TotalMinutes      : 3,12943333333333
  TotalSeconds      : 187,766
  TotalMilliseconds : 187766
```

And that's how the command line could look that ends all processes called Notepad that have not been running for longer than three minutes:

```
Get-Process notepad | ForEach-Object {
  $time = (New-TimeSpan $_.StartTime (Get-Date)).TotalSeconds;
  if ($time -lt 180) {
    "Stop process $($_.id) after $time seconds...";
    $_.Kill()
  }
  else {
    "Process $($_.id) has been running for " +
    "$time seconds and have not be stopped."
  }
}
```

These lines function extremely well, but are somewhat unclear. The *ForEach-Object* loop contains a condition. That's actually where *Where-Object* can come in:

```
Get-Process notepad |
  Where-Object {
    $time = (New-TimeSpan $_.StartTime (Get-Date)).TotalSeconds;
    ($time -lt 180)
  } |
  ForEach-Object {
    "Stop process $($_.id) after $time seconds...";
    $_.Kill()
  }
```

This works, too. Now, while you have separated condition and loop, you have been confronted with a disadvantage of *Where-Object*: this cmdlet allows only those objects to pass that match your condition. All the others will quietly vanish. That's why this approach doesn't have any option to output a notification about processes that have already been running for a longer period of time and have not been stopped. Perhaps you still remember from Chapter 7 that *Switch* combines the features of a loop and a condition. If you need both, *Switch* can be a useful solution:

```
Switch (Get-Process notepad) {
  {
    $time = (New-TimeSpan $_.StartTime (Get-Date)).TotalSeconds;
    $time -le 180
  }
    {
      "Stop process $($_.id) after $time seconds...";
      $_.Kill()
    }
  default {"Process $($_.id) has been running for some time and will not be
stopped."}
}
```

Foreach

Aside from *ForEach-Object*, PowerShell also comes with the *Foreach* statement. At first glance, both appear to work nearly identically. While *ForEach-Object* obtains its entries from the pipeline, the *Foreach* statement iterates over a collection of objects:

```
# ForEach-Object lists each element in a pipeline:
Dir C:\ | ForEach-Object { $_.name }
# Foreach loop lists each element in a colection:
Foreach ($element in Dir C:\) { $element.name }
```

And here is precisely the basic difference between them. *ForEach-Object* works best in a pipeline, where each result is returned by the preceding command in real time. *Foreach* can only process objects that are already completely available. *Foreach* blocks PowerShell until all results are available; for complex commands that can take a very long time. *Foreach* processes the objects only *after Dir* has retrieved them:

```
# Foreach loop lists each element in a collection:
Foreach ($element in Dir C:\ -recurse) { $element.name }
```

Now you won't see anything at all for a long time—at most a few strange error messages. The reason is that you have assigned *Dir* the task of recursively retrieving the directory listing for the entire C:\ drive, and that can take some time. The error messages that may appear come from directories for which you have no read rights. The *Foreach* loop cannot go into action until the *Dir* result is completely available.

The PowerShell pipeline does a better job. In it, *Dir* gets its results one at a time so that *ForEach-Object* can already work through them while *Dir* is still performing its task. This means that there's no delay, and everything proceeds in real time. In other words, *ForEach-Object* processes the results of *Dir while Dir* returns them:

```
# ForEach-Object lists each element in a pipeline:
Dir C:\ -recurse | ForEach-Object { $_.name }
```

What are the special strengths of *Foreach*? It is the better choice whenever the results that you want to evaluate are already completely available, such as in a variable, because it is considerably quicker.

Let's read all elements of an array using a Foreach loop.

```
# Create your own array:
$array = 3,6,"Hello",12
# Read out this array element by element:
Foreach ($element in $array) {"Current element: $element"}

  Current element: 3
  Current element: 6
  Current element: Hello
  Current element: 12
```

tip

ForEach-Object and the pipeline could also iterate through an array:

```
    $array = 3,6,"Hello",12
$array | ForEach-Object { "Current element: $_" }
```

But Foreach is significantly quicker. You can find out how dramatic the time advantage is by using Measure-Command cmdlet:

```
(Measure-Command {
  $array | ForEach-Object { "Current element: $_" }
}).totalmilliseconds

  2.8

(Measure-Command {
  Foreach ($element in $array) {"Current element: $element"}
}).totalmilliseconds

  0.2
```

If the objects are already in a variable, it's more than 10 times faster to use *Foreach* to evaluate them directly than to drive them through the pipeline.

The following rules can be deduced:

- **ForEach-Object:** If you have to acquire the results first, and if this acquisition lasts longer than a few milliseconds, then use *ForEach-Object* and the pipeline so that you won't have to wait for long periods of time and the results are processed immediately where they are available.
- **Foreach:** If you have the results already available in a variable or if their acquisition is very fast, then use *Foreach* because of its speed advantage.

Foreach functions in principle with any kind of collection. For example, you could use *Dir* to obtain a directory listing and then use *Foreach* to further process each file and directory:

```
# Process all files and subdirectories in a directory separately:
Foreach ($entry in dir c:\) {
  # Either embed the data as subexpressions in a text:
  "File $($entry.name) is $($entry.length) bytes large"
  # Or use wildcards and the -f formatting operator:
  "File {0} is {1} bytes large" -f $entry.name, $entry.length
}

  File autoexec.bat is 24 bytes large
  File autoexec.bat is 24 bytes large
  File BOOTSECT.BAK is 8192 bytes large
  File BOOTSECT.BAK is 8192 bytes large
  (...)
```

note

The *Foreach* loop can also handle empty collections and even objects that aren't even collections. If *Dir* doesn't retrieve any files at all, the loop won't run a single time. If *Dir* returns just one file, then *Foreach* will automatically recognize that this is one single object, and it will run the loop exactly one time.

You could just as well have used the *Get-WmiObject* cmdlet to look for instances of a WMI class and had it retrieve all running services on your system. *Foreach* would then examine each of the services and generate a list with the general service names, as well as the localized service names:

```
# Use WMI to query all services of the system:
$services = Get-WmiObject Win32_Service
# Output the Name and Caption properties for every service:
Foreach ($service in $services) { $service.Name +
  " = " + $service.Caption }

  AeLookupSvc = Application Experience Lookup
  AgereModemAudio = Agere Modem Call Progress Audio
  ALG = Application Layer Gateway Service
  Appinfo = Application Information
  (...)
```

That, however, pushes things to the limit because *Get-WmiObject* may require several seconds in some circumstances. It would probably be better for you to use *ForEach-Object*.

In principle, *Foreach* requires only a collection of objects. Such collections, when you look closely, are widely distributed. The *Resolve-Path* cmdlet uses wildcards to change a path specification to an array with all actual paths matching the wildcard characters. The next example lists all the text files in your user profile:

```
Resolve-Path -Path "$home\*.txt"

  Path
  ----
  C:\Users\Tobias Weltner\output.txt
  C:\Users\Tobias Weltner\cmdlet.txt
  C:\Users\Tobias Weltner\error.txt
  C:\Users\Tobias Weltner\list.txt
  C:\Users\Tobias Weltner\snapshot.txt
```

The *Foreach* loop could now go through the result of *Resolve-Path* and open every single file it found in the Notepad:

```
function open-editor ([string]$path="$home\*.txt") {
  $list = Resolve-Path -Path $path
  Foreach ($file in $list) {
    "Open File $file..."
    notepad $file
  }
}
```

This line would then open all log files in your Windows subdirectory in the Notepad:

```
open-editor $env:windir\*.log
```

Now and then, commands like *Dir* (or *Get-Childitem*) retrieve several different object types, *FileInfo* objects for files and *DirectoryInfo* objects for directories. That doesn't matter to *Foreach*: every time a loop cycle is completed, *Foreach* will get an object until all objects are processed. However, it should matter a little to you, and so you could use a condition to test whether the retrieved object matches the desired type. The following loop gets different objects depending on whether it is a directory or a file:

```
# Process all files and subdirectories in a directory one by one:
Foreach ($entry in dir c:\) {
  # Is it a FileInfo object?
  if ($entry -is [System.IO.FileInfo]) {
    # If yes, output name and size:
    "File {0} is {1} bytes large" -f $entry.name, $entry.length
  }
  # Or is it perhaps a DirectoryInfo object?
  elseif ($entry -is [System.IO.DirectoryInfo]) {
    # If yes, output name and creation time:
    "Subdirectory {0} was created on {1:}" -f $entry.name,
      $entry.CreationTime
  }
}

  Documents and Settings subdirectory was created on
    08.28.2006 19:15:14
  Program Files subdirectory was created on 11.02.2006 12:18:33
  Programs subdirectory was created on 08.28.2006 19:15:47
  Users subdirectory was created on 11.02.2006 12:18:33
  Windows subdirectory was created on 11.02.2006 12:18:34
  autoexec.bat file is 24 bytes large
  BOOTSECT.BAK file is 8192 bytes large
  config.sys file is 10 bytes large
```

Do and While

Do and *While* generate endless loops. Endless loops are practical if you don't know exactly how long the loop should iterate. To prevent an endless loop to really run endlessly, you must set additional abort conditions. The loop will end when the conditions are met.

Continuation and Abort Conditions

A typical example of an endless loop is a user query that you want to iterate until the user gives a valid answer. How long that lasts and how often the query will iterate depends on the user and his ability to grasp what you want.

```
Do {
  $input = Read-Host "Your homepage"
} While (!($input -like "www.*.*"))
```

This loop asks the user for his home page Web address. At the end of the loop after *While* is the criteria that has to be *met* so that the loop can be iterated once again. In the example, *-like* is used to verify whether the input matches the www.*.* pattern. While that's only an approximate verification, usually it suffices. To refine your verification you could also use regular expressions. Both procedures will be explained in detail in Chapter 13.

This loop is supposed to iterate only if the input is *false*. That's why "!" is used to simply invert the result of the condition. The loop will then be iterated until the input does *not* match a Web address.

In this type of endless loop, verification of the loop criteria doesn't take place until the end. The loop will go through its iteration at least once, because before you can check the criteria, you have to query the user at least once.

However, there are also cases in which the criteria is supposed to be verified at the beginning and not at the end of the loop, namely whenever there are certain conditions when the loop must not go through any iteration. An example could be a text file that you want to read one line at a time. The file could be empty and the loop should check before its first iteration whether there's anything at all to read. To accomplish this, just put the *While* statement and its criteria at the beginning of the loop (and leave out *Do*, which is no longer of any use):

```
# Open a file for reading:
$file = [system.io.file]::OpenText("C:\autoexec.bat")
# Continue loop until the end of the file has been reached:
While (!($file.EndOfStream)) {
  # Read and output current line from the file:
  $file.ReadLine()
}
# Close file again:
$file.close
```

Using Variables as Continuation Criteria

The fact is that the continuation criteria after *While* works like a simple switch. If the expression is *$true*, then the loop will be iterated; if it is *$false*, then it won't. Conditions are therefore not obligatory, but just simply provide the required *$true* or *$false*. You could just as well have presented the loop with a variable as criteria as long as the variable contained *$true* or *$false*.

In such a way, you could have verified the criteria in the loop as well and stored the result in a variable. Then you could have used the verification result in the loop and output an explanatory text when the user gave false input so that he would know why he was being queried a second time:

```
Do {
  $input = Read-Host "Your Homepage"
  if ($input -like "www.*.*") {
    # Input correct, no further query:
    $furtherquery = $false
  } else {
    # Input incorrect, give explanation and query again:
    Write-Host -Fore "Red" "Please give a valid web address."
    $furtherquery = $true
  }
} While ($furtherquery)

  Your Homepage: hjkh
  Please give a valid web address.
  Your Homepage: www.powershell.com
```

Endless Loops without Continuation Criteria

In extreme cases, you should not use any continuation criteria at all but simply type the fixed value *$true* after *While*. The loop will then become a genuinely endless loop, which from then on will no longer stop on its own. Of course, that makes sense only if you exit the loop in some other way. The *break* statement makes that possible:

```
While ($true) {
  $input = Read-Host "Your homepage"
  if ($input -like "www.*.*") {
    # Input correct, no further query:
    break
  } else {
    # Input incorrect, give explanation and ask again:
    Write-Host -Fore "Red" "Please give a valid web address."
  }
}

  Your homepage: hjkh
  Please give a valid web address.
  Your homepage: www.powershell.com
```

For

If you know exactly how often you want to iterate a particular code segment, then use the *For* loop. *For* loops are counting loops, and when the loop is iterated often enough, it will end its iterations automatically. To define the number of iterations, specify the number at which the loop begins and at which number it will end, as well as which increments will be used for counting. The following loop will retrieve exactly seven lottery numbers for you. It begins counting at 0, counts until the value is less than seven, and increases the value by one with every new iteration.

```
# Create random number generator
$random = New-Object system.random
# Output seven random numbers from 1 to 49
For ($i=0; $i -lt 7; $i++) {
  $random.next(1,49)
}

  32
  29
  44
  43
  6
  38
  9
```

For Loops: Just Special Types of the While Loop

If you take a closer look at the *For* loop, you'll quickly notice that it is actually only a specialized form of the *While* loop. The *For* loop, in contrast to the While loop, evaluates not only one but three expressions:

- **Initialization:** The first expression is evaluated when the loop begins.
- **Continuation criteria:** The second expression is evaluated before every iteration. It basically corresponds to the continuation criteria of the *While* loop. If this expression is *$true*, the loop will iterate.
- **Increment:** The third expression is likewise re-evaluated with every looping, but it is not responsible for iterating. Be careful: this expression cannot generate output.

These three expressions are used to initialize a control variable, to verify whether a final value is achieved, and to change a control variable with a particular increment at every iteration of the loop. Of course, it is entirely up to you whether you want to use the *For* loop solely for this purpose.

A *For* loop can become a *While* loop if you ignore the first and the third expression and only use the second expression, the continuation criteria:

```
# First expression: simple While loop:
$i = 0
While ($i -lt 5) {
  $i++
  $i
}

  1
  2
  3
  4
  5

# Second expression: the For loop behaves like the While loop:
$i = 0
For (;$i -lt 5;) {
  $i++
  $i
}

  1
  2
  3
  4
  5
```

Unusual Uses for the For Loop

Of course, it might have been preferable in this case to use the *While* loop right from the beginning. It certainly makes more sense not to ignore the other two expressions of the *For* loop, but to use them for other purposes. The first expression of the *For* loop can be used in general for initialization tasks. The third expression could set the increment of a control variable as well as perform different tasks in the loop. You could also use it, in fact, in the user query example we just had:

```
For ($input=""; !($input -like "www.*.*");
     $input = Read-Host "Your homepage") {
  Write-Host -fore "Red" " Please give a valid web address."
}
```

In the first expression, the *$input* variable is set to an empty string. The second expression checks whether a valid Web address is in *$input*, and if it is, it uses "!" to invert the result so that it is *$true* if an invalid Web address is in *$input*. In this case, the loop is iterated. In the third expression, the user is queried for a Web address. Really nothing more needs to be in the loop. In the example, an explanatory text is output.

In addition, the line-by-line reading of a text file can be implemented by a *For* loop with less code:

```
For ($file = [system.io.file]::OpenText("C:\autoexec.bat");
     !($file.EndOfStream); $line = $file.ReadLine())
{
  # Output read line:
  $line
}
$file.close()

  REM Dummy file for NTVDM
```

In this example, the first expression of the loop opened the file so it could be read. In the second expression, a check is made whether the end of the file has been reached. The "!" operator inverts the result again so that it returns *$true* if the end of the file hasn't been reached yet so that the loop will iterate in this case. The third expression reads a line from the file. The read line is then output in the loop.

note

The third expression of the *For* loop is executed before every loop cycle. In the example, the current line from the text file is read. This third expression is always executed invisibly; that means you can't use it to output any text. So, the contents of the line are output within the loop.

Switch

Do you still remember the *Switch* statement discussed in Chapter 7? *Switch* is not only a condition but also functions like a loop. That makes *Switch* one of the most powerful statements in PowerShell. *Switch* works almost exactly like the *Foreach* loop. Moreover, it can evaluate conditions. For a demonstration, take a look at the following simple *Foreach* loop:

```
$array = 1..5
Foreach ($element in $array)
{
  "Current element: $element"
}

  Current element: 1
  Current element: 2
  Current element: 3
  Current element: 4
  Current element: 5
```

If you used *Switch*, this loop would look like this:

```
$array = 1..5
Switch ($array)
{
  Default { "Current element: $_" }
}

  Current element: 1
  Current element: 2
  Current element: 3
  Current element: 4
  Current element: 5
```

The control variable that returns the current element of the array for every loop cycle cannot be named for *Switch*, as it can for *Foreach*, but is always called *$_*. The external part of the loop functions in exactly the same way. Inside the loop, there's an additional difference: while *Foreach* always executes the same code every time the loop cycles, *Switch* can utilize conditions to execute optionally different code for every loop. In the simplest case, the *Switch* loop contains only the *default* statement. The code that is to be executed follows it in braces.

That means *Foreach* is the right choice if you want to execute exactly the same statements for every loop cycle anyway. On the other hand, if you'd like to process each element of an array according to its contents, it would be preferable to use *Switch*:

```
$array = 1..5
Switch ($array)
{
  1  { "The number 1" }
  {$_ -lt 3}  { "$_ is less than 3" }
  {$_ % 2}  { "$_ is odd" }
  Default { "$_ is even" }
}

  The number 1
  1 is less than 3
  1 is odd
  2 is less than 3
  3 is odd
  4 is even
  5 is odd
```

If you're wondering why *Switch* returned this result, take a look at Chapter 7 where you'll find an explanation of how *Switch* evaluates conditions. What's important here is the other, loop-like aspect of *Switch*.

Processing File Contents Line by Line

If you need conditions in your loop, *Switch* is a clever alternative to *Foreach*. The same thing is true when you want to process text files, because if you wish *Switch* will treat a text file like an array and the lines it contains like elements in the array. This means that you don't have to worry about how to open files for reading; you can just leave that up to *Switch*.

For example, an interesting text file is windowsupdate.log in the Windows subdirectory because it records all updates of the operating system. Because the system often has exclusive access to this file, the following code copies the file and then uses *Switch* to output its contents line by line. Afterwards, the copy is deleted:

```
Copy-Item $env:windir\windowsupdate.log example.log
Switch -file example.log
{
  Default  { "read: $_" }
}
Remove-Item example.log
```

Switch is really too sophisticated a tool for just opening a text file and outputting its contents line by line. If all you were interested in was the entire text content of the file, you could have output it more easily:

```
Get-Content $env:windir\windowsupdate.log
```

The strength of *Switch* lies in its ability to evaluate single lines of a text file and then output only particular data. Because this is really a case for regular expressions, you'll find numerous examples in Chapter 13.

Exiting Loops Early

You can exit all loops by using the *Break* statement, which gives you the additional option of defining additional stop criteria in the loop. The following is a little example that asks for a password and then uses *Break* to exit the loop as soon as the password "secret" is entered.

```
While ($true)
{
  $password = Read-Host "Enter password"
  If ($password -eq "secret") {break}
}
```

The *Break* statement is actually unnecessary in this loop because you could have also stopped the loop by using the usual continuation criteria. You just have to consider here whether the iteration criteria should be verified at the beginning (and then you'd use *While*) or at the end (and then *Do...While*) of the loop:

```
Do
{
  $password = Read-Host "Enter password"
} While ($password -ne "secret")
```

It would make more sense to use *Break* in *For* loops, because in *For* loops you can optimally combine the unscheduled *Break* with the scheduled iteration criteria of the loop. Perhaps you'd like to give users just three tries at entering a correct password. The following loop asks for a password a maximum three times, but can, thanks to *Break*, be exited earlier when the correct password is entered:

```
For ($i=0; $i -lt 3; $i++)
{
  $password = Read-Host "Enter password ($i. try)"
  If ($password -eq "secret") {break}
}
```

But the *For* loop would not only give up after a maximum three tries, but would also grant you access even without the right password. To prevent that from happening, after the third unsuccessful try, you should trigger an error:

```
For ($i=1; $i -lt 4; $i++)
{
  $password = Read-Host "Enter password ($i. try)"
  If ($password -eq "secret") {break}
  If ($i -ge 3) { Throw "The entered password was incorrect." }
}
```

tip

What you see here is only a very simple password query showing the password in plain text. Secure password queries that have encrypted input will be covered in Chapter 13 in connection with the feature called *SecureStrings*.

Continue: Skipping Loop Cycles

The *Continue* statement operates somewhat more mildly than *Break*, because *Continue* won't force you to exit the entire loop right away but will only skip the current loop cycle. Let's look at the *Foreach* loop that cycles through all elements of a collection. In this case, *Dir* will supply the collection and the collection will hold the contents of a directory. These contents can consist of files and subdirectories; and, as you should know by now, files are represented by a *FileInfo* and sub-directories by a *DirectoryInfo* object.

So, when you want to process just files and not directories in the *Foreach* loop, then you should initially verify the type of the respective object. If the type doesn't match the *FileInfo* object, provide the *Continue* statement: the loop will then stop its current cycle immediately and continue with the next element:

```
Foreach ($entry in Dir $env:windir)
{
  # If the current element matches the desired type,
  # continue immediately with the next element:
  If (!($entry -is [System.IO.FileInfo])) { Continue }
  "File {0} is {1} bytes large." -f $entry.name, $entry.length
}
```

Of course, you could have also achieved the same thing if you had used a condition to sub-divide the entire contents of the loop, though usually that is substantially less clear:

```
Foreach ($entry in Dir $env:windir)
{
  If ($entry -is [System.IO.FileInfo]) {
    "File {0} is {1} bytes large." -f $entry.name, $entry.length
  }
}
```

Nested Loops and Labels

Loops may be nested within each other. However, if you do nest loops, the question arises of how their *Break* and *Continue* statements will behave. Of course, they will behave for the time being the way you expect them to and will always have an effect on the current loop in which they were invoked.

The next example nests two *Foreach* loops. The first (outer) loop cycles through a field with three WMI class names. The second (inner) loop runs through all instances of the respective WMI class. In this way, you could output all instances of all three WMI classes. The inner loop checks whether the name of the current instance begins with "a"; if not, the inner loop invokes *Continue* and so skips all instances not beginning with "a." The result is a list of all services, user accounts, and running processes that begin with "a":

```
Foreach ($wmiclass in "Win32_Service","Win32_UserAccount","Win32_Process")
{
  Foreach ($instance in Get-WmiObject $wmiclass) {
    If (!(($instance.name.toLower()).StartsWith("a"))) {continue}
```

```
      "{0}: {1}" -f $instance.__CLASS, $instance.name
    }
  }

    Win32_Service: AeLookupSvc
    Win32_Service: AgereModemAudio
    Win32_Service: ALG
    Win32_Service: Appinfo
    Win32_Service: AppMgmt
    Win32_Service: Ati External Event Utility
    Win32_Service: AudioEndpointBuilder
    Win32_Service: Audiosrv
    Win32_Service: Automatic LiveUpdate - Scheduler
    Win32_UserAccount: Administrator
    Win32_Process: Ati2evxx.exe
    Win32_Process: audiodg.exe
    Win32_Process: Ati2evxx.exe
    Win32_Process: AppSvc32.exe
    Win32_Process: agrsmsvc.exe
    Win32_Process: ATSwpNav.exe
```

As expected, the *Continue* statement in the inner loop had an effect on the inner loop in which the statement was contained. But how should you proceed if you'd like to see only the first respective element of all services, user accounts, and processes that begins with "a"? Actually, nearly the exact same way, only in this case *Continue* would have to have an effect on the outer loop. As soon as an element is found that begins with "a," the outer loop should jump to the next WMI class.

So that statements like *Continue* or *Break* know which loop they are supposed to relate to, you should give loops unambiguous names and then specify these names after *Continue* or *Break*:

```
  :WMIClasses Foreach ($wmiclass in
    "Win32_Service","Win32_UserAccount","Win32_Process") {
    :ExamineClasses Foreach ($instance in
      Get-WmiObject $wmiclass) {
      If (($instance.name.toLower()).StartsWith("a")) {
        "{0}: {1}" -f $instance.__CLASS, $instance.name
        continue WMIClasses
      }
    }
  }

    Win32_Service: AeLookupSvc
    Win32_UserAccount: Administrator
    Win32_Process: Ati2evxx.exe
```

Summary

The cmdlet *ForEach-Object* gives you the option of processing single objects of the PowerShell pipeline, such as to output the data contained in object properties as text or to invoke methods of the object. *Foreach* is a similar type of loop whose contents do not come from the pipeline, but from an array or a collection.

In addition, there are endless loops that iterate a code block until a particular condition is met. The simplest type of such loops is *While*, in which continuation criteria are checked at the beginning of the loop. If you want to do the checking at the end of the loop, choose *Do...While*. The *For* loop is an extended *While* loop, because it can count loop cycles and automatically terminate the loop after a designated number of iterations.

This means that *For* is suited mainly for loops in which counts are to be made or which must complete a set number of iterations. *Do...While* and *While*, on the other hand, are suited for loops that have to be iterated as long as the respective situation and running time conditions require it.

Finally, *Switch* is a combined *Foreach* loop with integrated conditions so that you can immediately implement different actions independently of the read element. Moreover, *Switch* can step through the contents of text files line by line and evaluate even log files of substantial size.

All loops can exit ahead of schedule with the help of *Break* and skip the current loop cycle with the help of *Continue*. In the case of nested loops, you can assign an unambiguous name to the loops and then use this name to apply *Break* or *Continue* to nested loops.

CHAPTER 9.

Functions

PowerShell has the purpose of solving problems, and the smallest tool it comes equipped with for this is commands. By now you should be able to appreciate the great diversity of the PowerShell command repertoire: in the first two chapters, you already learned how to use the built-in PowerShell commands called cmdlets, as well as innumerable external commands, such as *ping* or *ipconfig*. In Chapter 6, the objects of the .NET framework, and COM objects were added, providing you with a powerful arsenal of commands.

In Chapters 3, 4, and 5, command chains forged out of these countless single commands combined statements either by using variables or the PowerShell pipeline.

The next highest level of automation is functions, which are self-defined commands that internally use all of the PowerShell mechanisms you already know, including the loops and conditions covered in the last two chapters.

Topics Covered:

Creating New Functions

Functions are self-defined new commands consisting of general PowerShell building blocks. They have in principle three tasks:

- **Shorthand:** very simple shorthand for commands and immediately give the commands arguments to take along
- **Combining:** functions can make your work easier by combining several steps
- **Encapsulating and extending:** small but highly complex programs consisting of many hundreds of statements and providing entirely new functionalities

The basic structure of a function is the same in all three instances: after the *Function* statement follows the name of the function, and after that the PowerShell code in braces. Let's take a look at couple of examples:

First Example: Shorthand Functions

Perhaps you'd simply like to create comfortable shorthand for the customary console commands you already know. If PowerShell doesn't accept the "*Cd..*" entry because the mandatory blank character isn't interposed between command and argument, then create the appropriate shorthand function on the spot—and the problem will be solved right away:

```
Function Cd.. { Cd .. }
Cd..
```

Whenever you enter the *Cd..* command afterwards, you won't get any error messages because PowerShell will invoke your function.

When you find yourself still repeatedly entering the same lengthy commands, functions may be the remedy. For example, if you're frequently using ping.exe with certain parameters, like *ping.exe -w 100 -n 1 10.10.10.10*, then this function will save you time:

```
Function myPing { ping.exe -w 100 -n 1 10.10.10.10 }
myPing

  Pinging 10.10.10.10 with 32 bytes of data:
  Reply from 88.70.64.1: destination host unreachable.
```

However, this function would be inflexible in practice; it would ping the same network address again and again. That's why most functions use arguments. Everything the caller specifies after the function name is in the *$args* variable. Let's modify our *myPing* function to ping any address.

```
Function myPing { ping.exe -w 100 -n 1 $args }
myPing www.microsoft.com

  Pinging lb1.www.ms.akadns.net [207.46.193.254] with 32 bytes of data:
  Request timed out.
  Ping statistics for 207.46.193.254:
      Packets: Sent = 1, Received = 0, Lost = 1 (100% Loss),
```

As you see, you only need to type the function again in order to overwrite the old version.

Second Example: Combining Several Steps

You might often need the nearest unallocated drive letter. The *NextFreeDrive* function can locate it. But before you try out the function and think about how to make it work, you should first answer the question of how to enter such a lengthy function.

```
Function NextFreeDrive
{
  For ($x=67; $x -le 90; $x++)
  {
    $driveletter = [char]$x + ":"
    If (!(Test-Path $driveletter))
    {
      $driveletter
      break
    }
  }
}
```

Comfortably Entering Functions of Several Lines

Typing short functions is no problem but when a function consists of more than one line, PowerShell immediately activates its multiline mode, alerting you by the prompt symbol ">>":

```
Function NextFreeDrive
>> {
>>  For ($x=67; $x -le 90; $x++)
(...)
```

Once the multiline mode is turned on, you have to type the entire function to the end. The prompt symbol ">>" will appear a last time, but when you press (Enter), the function will be operational. This kind of typing is not very user friendly, and when you make a typing mistake somewhere and forget a brace or quotation mark, you won't even be able to exit the multiline mode. Then it's time to cancel the multiline mode by hitting (Ctrl)+(C) and to begin all over again or to think about other options.

Reducing a Function to a Single Line

You could enter the function in just a single line, but it's not necessarily wise because then the function will hardly be understandable. If you want to reduce functions to a single line, then add a semi-colon after every command:

```
Function NextFreeDrive{For($x=67;$x -le 90;$x++){$driveletter=[char]$x+":";
If(!(Test-Path $driveletter)){$driveletter;break}}}
```

Using Text Editors

Functions can be written more easily in text editors. Even the Notepad is adequate. Start the Notepad with the *Notepad* command, type the function and when it's done, mark the entire text and copy it to the Clipboard. Afterwards, switch to the PowerShell console and right-click in it. If *QuickEdit* mode is active (see Chapter 1), the function code will be immediately inserted; if not, select *Paste* from the context menu. Special PowerShell editors like *PowerShellPlus* by *Idera* offer even more help.

Understanding NextFreeDrive

NextFreeDrive is an example of a function that doesn't require any arguments but supplies a return value:

```
NextFreeDrive

  D:

$lw = NextFreeDrive
$lw

  D:
```

So, let's take a look at how *NextFreeDrive* finds the next free drive letter and then reports back on it with a return value. The core of the function is a *For* loop (see Chapter 8) that counts from *67* to *90*:

```
For ($x=67; $x -le 90; $x++)
{ $x }

  67
  68
  69
  (...)
  89
  90
```

The function needs drive letters and it makes use of the fact that every letter is layered over ANSI code and the letters from "C" to "Z" have the ANSI codes from 67 to 90. To turn these numbers into letters, the function uses the type conversion we saw in Chapter 6 and converts the number into a character:

```
For ($x=67; $x -le 90; $x++)
{ [char]$x }

  C
  D
  E
  F
  (...)
  X
  Y
  Z
```

So, the loop returns letters, and the function in *$driveletter* changes them to drive letters by appending a colon. *Test-Path* cmdlet can verify whether this path already exists. If yes, the letter is already allocated. The function must return the first letter that is not allocated, so the result of that test has to be inverted by "!".

So, if *Test-Path* returns *False*, the drive letter is still unallocated. By using "!", *If* gets *True*, the condition is met, and the code in the braces after *If* is executed. It defines the return value of the function by outputting the contents of *$driveletter*. Because the drive letter has been located, the *For* loop can now be interrupted by *break*.

Processing and Modifying Functions

If you'd like to make a change to an existing function, the usual advice is to just enter the function again. New version automatically overwrites old version. If you haven't stored the code of your function in an external editor, it's no fun to type it all over again, especially for really long functions.

You can also convert functions into a script, an external file that has the ".psl" file extension.

```
# The next two commands both store the content of the tabexpansion function in a
file:
$function:tabexpansion | Out-File myscript.ps1
$function:tabexpansion > myscript.ps1
# Notepad opens the file:
notepad $$
```

The last line used to open the file in the Notepad is a little unusual. You can specify the name of the file after *notepad*, but *$$* is shorter and easier. This special variable always contains the last token of the last pipeline. In this case, the last token was the name of the file.

Does it really matter whether you use *Out-File* or the redirection character to write the code of the function to a file? If you have to take care of *encoding*, use the *Out-File* cmdlet. It allows you to use the *-encoding* parameter to define encoding yourself.

pro tip

Do you still remember how you write-protected variables in Chapter 3 or declared them as constants? This always works for functions as you can create write-protected functions that can't be modified:

```
Set-Item function:test {
  "This function can neither be deleted nor modified."} -option
constant
test
```

Try to use *Del function:test* to delete the function or *function test { "Hello" }* to overwrite it—both will fail. The function will not be deleted until PowerShell exits. If you create the function right away when PowerShell starts as part of a self-starting profile script (see the next chapter), nobody will be able to make any more changes to the function.

Removing Functions

Normally, you don't need to remove functions yourself. That's taken care of when you exit PowerShell. However, if you'd like to delete a function immediately, here is how you'd accomplish it:

```
# Remove the function called "test":
Del function:test
# The "test" function is deleted and can no longer be found:
test

  The term "test" is not recognized as a cmdlet, function, operable
  program, or script file. Verify the term and try again.
  At line:1 char:4
  + test <<<<
```

Passing Arguments to Functions

It's true that functions can work completely autonomously, executing exactly the same commands whenever they're called. But usually that doesn't make sense. It's more often the case that you want functions to process given data or to control them to a certain extent. You can accomplish that by using arguments, which is additional information that you pass when calling a function. How you pass these arguments to your function is a matter of personal preference:

- **Arbitrary arguments:** the *$args* variable contains all the arguments that are passed to a function. This is a good solution to implementing optional (voluntary) arguments.
- **Named arguments:** a function can also assign a fixed name to arguments, ensuring that these arguments are mandatory. In addition, users can use parameters to name named arguments so that they won't have to be specified in a set sequence.
- **Predefined arguments:** arguments may include default values. If the caller doesn't specify any of his own arguments to the function, the appropriate default value will be used.
- **Typed arguments:** arguments can be defined for particular data types to make sure that the arguments correspond to a certain data type. This works in principle exactly like the typed variables covered in Chapter 3.

- **Special argument types:** aside from conventional data types, arguments can also act like a switch: if a switch (i.e., the name of the argument) is specified, the argument has the *$true* value.

$args: Arbitrary Arguments

The simplest way to pass arguments to a function is to use the *$args* variable. It contains the arguments specified when a function is called, and then it is entirely up to the function itself to decide what to do with the contents of *$args*.

Because a function has no mandatory requirement for arguments, none have to be given. Arguments are voluntary or optional. Moreover, because *$args* can hold any number of arguments, a function isn't restricted to a limited number of arguments either. Here's a test function that will give you your first overview of how *$args* works:

```
function Howdy {
  If ($args -ne $null) {
    "You specified: $args"
    "Argument number: $($args.count)"
    $args | ForEach-Object { $i++; "$i. Argument: $_" }
  } Else {
    "You haven't specified any arguments!"
  }
}
```

When you call this function without any arguments, it will detect that *$args* is empty and will output the relevant text. Now, try how the function behaves with various arguments:

```
# The function notices when you haven't specified any arguments:
Howdy

  You haven't specified any arguments!

# Arguments are specified directly after the function name:
Howdy Tobias

  You specified: Tobias
  Argument number: 1
  1. Argument: Tobias

# Several arguments are separated by blank characters:
Howdy Tobias Weltner

  You specified: Tobias Weltner
  Argument number: 2
  1. Argument: Tobias
  2. Argument: Weltner

# Text in quotation marks is evaluated as a single argument:
Howdy "Tobias Weltner"
```

```
  You specified: Tobias Weltner
  Argument number: 1
  1. Argument: Tobias Weltner

# When used in PowerShell, the comma generally creates an array
Howdy Tobias, Weltner

  You specified: System.Object[]
  Argument number: 1
  1. Argument: Tobias Weltner
```

The most important insight is that arguments are separated by blank characters, and if there's any white space in a text, the text has to be placed within quotation marks. This isn't a new rule. It applies to everything in PowerShell, including to cmdlets and their parameters. You'll find individual arguments as elements in the *$args* array. The first argument will be in *$args[0]*, the second in *$args[1]*, and so on.

In contrast, if you use commas to separate arguments, you'll be generating an array (see Chapter 4). The entire array can be found as a single argument in *$args*. Just take a look:

```
function test {
  Foreach ($element in $args) {
  $i++
  If ($element -is [array]) {
    "$i. Argument is an array: $element"
    } Else {
    "$i. Argument is not an array: $element"
    }
  }
}
test Hello test

  1. Argument is not an array: Hello
  2. Argument is not an array: test

test Hello,test value1 value2

  1. Argument is an array: Hello test
  2. Argument is not an array: value1
  3. Argument is not an array: value2
```

It's important to realize that if you'd like to assign more than one value to an argument, then you should make a list of comma-separated values and pass an array to this argument. This works the same way for cmdlets and is a very important basic PowerShell principle. For example, the following line would list the directory contents of *C:\* and *C:\Users* as well as all DLL files beginning with "p" in the Windows system directory:

```
Dir c:\, c:\users, $env:windir\system32\p*.dll
```

This is possible because *Dir* in this case contains only one single argument of yours, but it is an array that includes three elements. If you wanted to enable your own functions to accept arrays as arguments as well, you could try this:

```
function SaySomething {
  # No argument was given:
  If ($args -eq $null)
  {
    "No arguments"
    # An array was specified as the first argument,
    # so the function calls itself again
    # for every argument in the array:
  }
  ElseIf ($args[0] -is [array])
  {
    Foreach ($element in $args[0])
    {
      SaySomething $element
    }
    # The first argument is not an array; the actual task was not completed:
  }
  Else
  {
    "Howdy, $args"
  }
}
```

If you pass a comma-separated list to the function, it will recognize that the first argument (*$args[0]*) is an array. The function then picks out the array elements separately in a *Foreach* loop and invokes itself again with each separate element. Now your function is just as flexible as most cmdlets and can process an individual argument as well as a comma-separated list:

```
SaySomething Tobias

  Howdy, Tobias

SaySomething Tobias, Martina, Cof

  Howdy, Tobias
  Howdy, Martina
  Howdy, Cof
```

If you'd like to refer to certain arguments, just remember again that *$args* is an array. That means you can refer to each argument as you would with an array, by using an index, beginning at position 0. So, you'll find the first argument in *$args[0]*. Knowing this, you can make your own little function that adds two numbers together:

```
Add function{ $args[0] + $args[1]}
Add 1 2

  3
```

Because *$args* is an array and you can find out at any time which elements are in this array, you could reformulate the function so that it would add as many numbers *as you wish*:

```
Add function
```

```
{
  Foreach ($number in $args)
  {
    $result += $number
  }
  "Total: $result"
}
Add 1 4 5 12 436

  Total: 458
```

Setting Parameters

While *$args* contains all the arguments that you pass to a function, that really isn't so useful. Because *$args* is an array, you're continually forced to access unreadable array elements. It would be easier if the passed arguments were available with their own names in separate variables. That is possible without too much effort by using a trick. In Chapter 3, you learned that you can assign variables not only separate values but also fill several variables with different values in one fell swoop.

The trick here is arrays. If you specify on the left side of an assignment operator a comma-separated variable list, then the contents of an array on the right side will be assigned to it. *$args* is an array, and that's why you could use this method of assigning to sub-divide the contents of *$args* into separate variables that are easier to handle:

```
function Add {
$Value1, $Value2 = $args
$Value1 + $Value2
}
Add 1 6

  7
```

You no longer need to access the elements in *$args* within the function, but can use the named variables into which you sub-divided the contents of *$args*. However, the arguments used in this approach are still always optional. You can also specify fewer or more than two arguments, which becomes a problem as soon as you specify more than two arguments:

```
Add 1 2 3

  "System.Object[]" cannot be converted to "System.Int32".
  At line:3 char:9
  + $value1 +  <<<< $value2
```

To understand why, take a look at the following example. The user had specified three arguments as *$args* contained three elements. The function distributed these three elements between two variables. The first variable got the first element and the second variable got *all the others*:

```
$value1, $value2 = 1,2,3
$value1
```

```
    1

  $value2

    2
    3
```

Despite all of PowerShell's capabilities, it cannot add a number with an array so you get an error. The reason is that the function accepts any number of arguments. If you want to specify a fixed number of arguments instead of any number of arguments, then lock in the expected arguments in the function description by defining the parameters:

```
  Function subtract($Value1, $Value2) {
   $value1 - $value2
   }
  Subtract 5 2

    3

  Subtract 5

    5
```

note By the way, arguments and parameters, while not the same, at least have a friendly relationship. What the user passes to a function in the way of additional information are arguments. They originate from whatever invokes the function. The function itself can define parameters. The user's arguments are then assigned to the parameters.

However, both parameters are not really mandatory. They only make sure that the user's arguments won't end up any more in the *$args* general container, but are clearly assigned to particular parameters: parameter binding. If the user doesn't specify an argument that you required, the parameter will automatically be assigned an empty value (*$null*) instead of generating an error. You'll read a little later about how you can ensure that the arguments you require really do get specified.

A great advantage of parameters is that arguments no longer need to be given in a fixed order. If you want to specify the argument for the *Value2* parameter first and only afterwards the argument for the *Value1* parameter, then type the parameter name before every argument for which it is meant. Writing it this way is nothing new: all cmdlets also work according to this principle:

```
  # Named arguments can be assigned using parameters;
  # a fixed sequence isn't necessary:
  Subtract -Value1 12 2

    10
```

```
Subtract -Value2 12 2

  -10
```

At first, PowerShell "binds" the arguments that you have locked in to a parameter in the above way. Subsequently, all the other arguments not yet assigned to a parameter will be bound in the specified order to the parameters yet to be taken care of. So, if you bind the first argument to the *Value2* parameter, the second argument, the number 2, remains. It can now be assigned to the first parameter that hasn't been looked after yet, *Value1*.

A second advantage is that your function will now be immune to additionally specified arguments. If the user gives more arguments than you asked for, nothing bad will happen. His additional statement will simply be ignored.

```
# Unnecessary arguments will be ignored:
Subtract 5 2 3

  3
```

However, they won't really be ignored. All the arguments that you didn't assign to unnamed arguments will end up in *$args* again. As a result, you can check or query any number of additional voluntary statements to see whether additional arguments have been specified, and then use *Throw* to generate an appropriate error message:

```
# This function won't accept any optional arguments:
Subtract function($Value1, $Value2)
{
  # Verify whether there are additional inputs;
  # if yes, generate an error message:
  If ($args.Count -ne 0) {
    Throw "I don't need any more than just two arguments." }
  $value1 - $value2
}
Subtract 1 2

  -1

# If there are more than the two required arguments,
# the function will generate an error message:
Subtract 1 2 3

  I don't need any more than just two arguments.
  At line:2 char:31
  + If ($args.Count -ne 0) { Throw  <<<<
  "I don't need any more than just two arguments."}
```

Arguments Having Predefined Default Values

You have just seen that functions with fixed parameters will not output errors if *fewer* arguments are given than what are asked for. Instead, parameters that haven't been taken care of yet will just simply be left empty. However, they don't have to remain empty, because by using default values you can determine which value a parameter is supposed to have if a user omits the argument.

```
# This function uses fixed default values for its parameters:
function subtract($Value1=10, $Value2=20)
{
  $value1 - $value2
}
# If no argument is given, the function
# will use the supplied default value:
Subtract

  -10

# If arguments are incomplete, the function will use the
# following defaults for the missing arguments:
Subtract -Value1 30

  10

Subtract -Value2 100

  -90
```

Can you require that the user *must* give the requested arguments? That will also work because fixed values are not only allowed as default values: sub-expressions are, too. Do you remember? Sub-expressions are always enclosed in parentheses and evaluated separately. The result of the sub-expression will be reported subsequently if you put a "$" before it. Take advantage of that if you want to make it mandatory for an argument to be specified for a parameter: as default value, assign to the parameter for which you make an argument obligatory a sub-expression that output an error message.

If the function is invoked without the mandatory argument, the function will try to use the default value and evaluate the sub-expression. The error message it contains will be output. This sounds much more complicated than it really is, as the next example shows:

```
# This function will report an error if the
# argument for "Value1" is not specified:
Subtract function($Value1=$(Throw "Value1 wasn't specified!"), $Value2=20)
{
  $value1 - $value2
}
# The second argument may be omitted; the default value will be used:
Subtract 10

  -10
```

```
# The first argument may not be omitted because
# the default value is an error message:
Subtract

  Value1 wasn't specified!
  At line:1 char:36
  + Subtract function($Value1=$(Throw  <<<< "Value1
    wasn't specified!"), $Value2=20) {
```

The fact that you may use complete sub-expressions as default values for parameters is useful in other situations as well. You can adjust parameters to current daily requirements, such as date, logon names, or any other information that has default value at the moment in which the function is invoked:

```
function Weekday ($date=$(Get-Date))
{
  $date.DayOfWeek
}
```

If you invoke your *Weekday* function without an argument, it will output the current day of the week. The standard value of the *$date* parameter is reset by the sub-expression, with the help of *Get-Date,* every time the function is invoked. If you specify another date after your function, you will, theoretically, find out on what day of the week the date falls. In practice, nothing at all happens. To find out why the function (still) doesn't work using its own arguments, read the next section.

Using Strongly Typed Arguments

You've just seen that things can get really muddled when the user's arguments are assigned to function parameters. The culprit is the argument parser, which takes the user's unprocessed arguments and distributes them among the function parameters.

The argument parser of functions is usually an arrogant guy who is completely indifferent to what information you give as argument. The argument parser is only interested in neatly splitting the raw data specified after the function into separate arguments and then passing these to the function parameters.

Of course, the function "sees" that quite differently because it must solve a very specific problem with the passed arguments and it doesn't care at all about what sort of arguments they are. That leads to trouble when the function expects arguments of a particular data type. This problem was already evident in the preceding examples, and you'll learn how to solve it in this section.

Only Numbers Allowed

Subtract function instantly throws an error if you pass string to it instead of numbers because it's impossible to "count" string:

```
Subtract Hello world
```

```
   Method invocation failed because [System.String]
   doesn't contain a method named "op_Subtraction".
   At line:3 char:9
   + $value1 -  <<<< $value2
```

Errors caused by mismatching data types are difficult to locate and remove because the resulting error message sounds confusing and the error is reported in a completely wrong location where the process is trying to get something done with an inappropriate data type.

It would make much more sense if the argument parser of the function hadn't accepted the mismatching arguments in the first place, which brings us to the solution: you can tell the argument parser which data types the parameters of your function can use. If the user specifies the wrong data types as an argument anyway, the argument parser will refuse to accept it and report the mistake with a much more explicit error message:

```
# This function accepts nothing but numbers as an argument:
function Subtract([int]$Value1, [int]$Value2)
{ $value1 - $value2 }
Subtract 5 2

  3

# As long as the argument can be converted
# to a number, the function is satisfied:
Subtract "5" 2

  3

# The function will accept no inputs that cannot
# be converted to numbers
Subtract Hello world

  subtract : cannot convert value "Hello" to type "System.Int32".
  Error: "input string was not in a correct format."
  At line:1 char:12
  + Subtract  <<<< Hello world
```

To get the argument parser to accept nothing but very specific data types, you should use the strong type specification that you learned about in Chapter 3. For that purpose, jot down the desired data type in brackets in front of the parameter. Effective immediately, the parameter will accept only numbers or information that can be changed to numbers. If the user specifies the wrong data type, an error will be generated that will now describe the cause with much greater clarity.

But watch out when you choose the data type for your arguments. Do you have any idea why your function returns the following results?

```
Subtract 8.2 0.2

  8

Subtract 8.2 1.4
```

```
    7

  Subtract 8.2 1.9

    6
```

Because your function expects the *Integer* data type for arguments, the specified floating point numbers are changed automatically to whole numbers and rounded off. To a certain extent, the same thing happens here:

```
  [int]1.4

    1

  [int]1.9

    2
```

So, if you'd like your function to handle floating point numbers properly, then you may not set the data type of the argument to *Integer*(*[int]*). Instead, use the *([double]*) floating point data type and the computational results will be correct:

```
function Subtract ([double]$Value1, [double]$Value2)
{
  $value1 - $value2
}
Subtract 8.2 0.2

  8

Subtract 8.2 1.4

  6.8

Subtract 8.2 1.9

  6.3
```

You can find an overview of the most used data types in Chapter 3.

Date Required

However, strong type specification is not only useful for rejecting mismatching data types. It can also be put to work to convert data types into a better format. You must surely remember the mysterious *Weekday* function, which would output the day of the week for the current date but not for the date that you specified. Without strong type specification, PowerShell automatically transformed your argument into the presumably matching data type, namely a string.

The function uses the *DayOfWeek* method to determine the weekday and because the *String* data type doesn't contain this method, the function consequently didn't return a result. You should know the solution by now: require the argument to be of the *DateTime* type. Then, the argument parser will, if possible, convert the input automatically into this type. If it isn't possible for it to convert the argument, an error will be generated:

```
function Weekday([datetime]$date=$(Get-Date))
{ $date.DayOfWeek }
Weekday 1.1.1980

  Tuesday

Weekday 1.2.1980

  Friday

Weekday sometime

  Weekday : Cannot convert value "sometime" to type
  "System.DateTime". Error: "The string was not
  recognized as a valid DateTime. There is an unknown
  word starting at index 0."
  At line:1 char:10
  + Weekday  <<<< sometime
```

"Switch" Parameter Is Like a Switch

The simplest conceivable parameter of a function contains just a binary yes/no value. This simple feature can (as an exception) even be represented entirely without an argument: if the parameter exists, then it will contain *$true*(for "yes"), otherwise *$false*(for "no"). If your function can utilize such yes/no decisions, then it can employ the simplified "switch" parameters, which are used most frequently to select special options. The following function, *WriteText*, writes text in the console. If you specify the *-inverse* switch, then the text will be output inversely:

```
Function WriteText([Switch]$inverse, $text)
{
  If ($inverse) {
    Write-Host -ForegroundColor "Black" `
      -BackgroundColor "White" $text
  } Else {
    $text
  }
}
```

If *-inverse* is specified as an argument, nothing new will happen: the argument parser will recognize that it is a parameter name. Normally, the parser would now assign the argument after *-inverse* to the parameter *$inverse*. However, because this parameter is of the *[Switch]* type, the argument parser "knows" that it is a simple parameter that can contain only *$true* or *$false*, and assigns it the *$true* value. On the other hand, if you don't specify *-inverse*, then the automatic default value of the parameter is *$false.*

Specifying Return Values of a Function

A function should ultimately return a result to whatever invoked the function. The examples of functions in this chapter have done their best to show that already. But exactly how functions return results is a highly interesting matter because functions work completely differently in PowerShell than in all other programming languages. That's reason enough to take a closer look at this aspect of functions.

One or More Return Values?

In fact, PowerShell functions don't return a single particular value. They simply return everything that they output at one juncture or another, while a function does its work. In the simplest case, that's just a single value, like the one in the following example. If you invoke the function interactively, the result will be output in the console. But you could just as well store the result of the function in a variable and process it further:

```
Function VAT([double]$amount=0)
{
  $amount * 0.19
}
# An interactively invoked function
# output results in the console:
VAT 130.67

  24.8273

# But the result of the function can
# also be assign to a variable:
$result = VAT 130.67
$result

  24.8273

# The result is a single number value
# of the "double" type:
$result.GetType().Name

  Double
```

In this example, the function returned a single number value. But what would happen if the function returned more than one result? To test that, we only need a function that output more than one result:

```
Function VAT([double]$amount=0)
{
  $factor = 0.19
  $total = $amount * $factor
  "Value added tax {0:C}" -f $total
  "Value added tax rate: {0:P}" -f $factor
}
```

```
# The function returns two results:
VAT 130.67

  Value added tax $24.83
  Value added tax rate: 19.00%

# All results are stored in a single variable:
$result = VAT 130.67
$result

  Value added tax $24.83
  Value added tax rate: 19.00%

# Several results are automatically stored in an array:
$result.GetType().Name

  Object[]

# You can get each separate result of the
# function by using the index number:
$result[0]

  Value added tax $24.83

# The data type of the respective array element
# corresponds to the included data:
$result[0].GetType().Name

  String
```

To summarize, if a function outputs only one value, then this value will be returned immediately. In this respect, functions behave very much like functions in other programming languages. On the other hand, if a function returns more than one value, then all the values will be wrapped in an array. However, often you won't even notice because PowerShell cleverly converted each of the elements in the array into string and output them one below the other when you output the array. As a result, at first sight it looks like all the output of the function had merged together to form a joint text.

That's not the case, as shown by the preceding example. Each result of the function is neatly segregated as a separate result so that you could pick a specific result out of the array and output it.

The Return Statement

You now know that functions basically return as a result everything that you output somewhere in the function. How to understand the special *return* statement that you see in the next example? Might it influence what a function returns as a result or does it even determine the result?

```
Function Add([double]$Value1, [double]$Value2)
{
  return $Value1 + $Value2
}
# The function returns the value that comes after "return":
Add 1 6

  7
```

It seems so—at least at first. In fact, *return* works quite differently. The function still returns as a result everything that is output in the function. But in addition (and not instead of this), a result is returned of what follows *return*. So, you could just as well have omitted *return*. That raises the question of why *return* was even invented.

- First, *return* exists for stylistic reasons because in many other programming languages it is customary to expressly specify values a function returns by using a statement like *return*. Unfortunately, *return* causes more confusion than it helps since it conceals the fact that all the other output of the function was returned, as well and not just what follows *return*.
- Second, to some extent *return* also acts like a break statement. All further statements after *return* are ignored. Therefore, you could immediately leave the function in a loop or a condition, provided that some particular interrupt criterion is met.

```
Function Add([double]$value1, [double]$value2)
{
  # This time the function returns a whole
  # series of oddly assorted results:
  "Here the result follows:"
  1
  2
  3
  # Return also returns a further result:
  return $value1 + $value2
  # This statement will no longer be executed
  # because the function will exit when return is used:
  "Another text"
}
Add 1 6

  Here the result follows:
  1
  2
  3
  7

$result = Add 1 6
$result

  Here the result follows:
  1
  2
  3
  7
```

Accessing Return Values

Whether a function returns one or several results is something you can verify with the returned data type. If it is an array, then several results were returned, otherwise only one. To examine this more closely, we will need a function that returns, depending on the situation, either one or several results. We could use the lottery number generator in the following example, which outputs random lottery numbers from 1 to 49. You can use the *$number* parameter to determine how many lottery numbers are returned. If you don't specify anything, exactly one lottery number will be generated. Your task now is to find out whether a function will retrieve exactly one or several results.

```
Function lottery([int]$number=1)
{
  $rand = New-Object system.random
  For ($i=1; $i -le $number; $i++) {
    $rand.next(1,50)
  }
}
# If a lottery number is queried, the result is not an array:
$result = lottery
$result -is [array]

  False

# If there are several lottery numbers, the result is an array:
$result = lottery 10
$result -is [array]

  True
```

Why should you be interested in whether the outcome of a function is one or several results? Among other things, you would like to find out exactly how many elements a result returns. In the case of our lottery number generator, of course, it makes less sense, because you can specify how many numbers it's supposed to generate. However, for other functions and cmdlets, the question can be decisive. Take the example of the *Dir* command, which lists the contents of a directory. If you want to know how many files are actually in a directory, then it's inevitable that you concern yourself with the question of whether *Dir* found none, exactly one, or many files.

If the directory holds more than one file, *Dir* will return an array, and you can ascertain the number of the elements (files) in the array by using *Count*:

```
(Dir c:\).Count

  25
```

Here, in the parentheses again is a sub-expression which must be evaluated first. You could just as well have written:

```
$list = Dir c:\
$list.count

  25
```

Things get thorny when *Dir* finds only one or no file at all, because then it doesn't return anymore arrays, and you can't use *Count*. An error will not be reported, just nothing at all:

```
   (Dir *.MacGuffin).Count
```

You could now, as shown above, verify whether *Dir* returns an array or not, and if what it returns is not an array, see whether one file or none at all was found. There's a far more elegant method for doing this, though. The result of a function (or of a cmdlet) can always be wrapped in an array, even if there is only one result or none. Use the *@(...)* construction that you already know from Chapter 4. You can usually use this construction to create new array. The result is wrapped in an array. If the result is an array anyway, naturally it will remain an array, but if the result is not an array, after this it will be one.

```
  @(Dir c:\).count

    25

  @(Dir *.MacGuffin).count

    0
```

Excluding Output from the Function Result

Now the result that the function is supposed to return just needs to be output somewhere in the function, which is convenient. But you'll still have to watch out that you don't mistakenly output anything that isn't part of the function result.

Excluding Text Output from the Result

During development, many script authors insert a little text output in the code so that they have a better grasp of whether a function is really doing what it should be doing. But you know now that this text output also ends up in the function result, causing considerable confusion. Take a look:

```
  Function Test
  {
   "Calculation will be performed"
    $a = 12 * 10
    "Result will be emitted"
    "Result is: $a"
   "Done"
  }
  Test

    Calculation will be performed
    Result will be emitted
    Result is: 120
    Done
```

At first everything looks absolutely impeccable: the function documents its internal sequence of operations by additional text output. But as soon as you fail to use the function interactively, storing the result in a variable instead, things change quite suddenly because your text comments will now no longer be output when the function runs but end up in the result:

```
# Your debugging report will not be emitted:
$result = Test
# In fact some debugging reports as well as all other output are in the result:
$result

  Calculation will be performed
  Result will be emitted
  Result is: 120
  Done
```

So, if you want to output text that is supposed to appear immediately and not flow into the function result, then this output must be sent directly to the console, which can be accomplished by using the *Write-Host* cmdlet:

```
Function Test
{
  Write-Host "Calculation will be performed"
  $a = 12 * 10
  Write-Host "Result will be emitted"
  "Result is: $a"
  Write-Host "Done"
}
# This time your debugging reports will already
# be output when the function is executed:
$result = test

  Calculation will be performed
  Result will be emitted
  Done

# The result will no long include your debugging reports:
$result

  Result is: 120
```

Using Debugging Reports

You would have to go to some trouble to remove these temporary messages when the function is ready and can be used in a production environment. You can save yourself the trouble by using the *Write-Debug* cmdlet for temporary text output.

```
Function Test
{
  Write-Debug "Calculation will be performed"
  $a = 12 * 10
  Write-Debug "Result will be emitted"
```

```
    "Result is: $a"
    Write-Debug "Done"
  }
  # Debugging reports will remain completely
  # invisible in the production environment:
  $result = Test
  # If you would like to debug your function,
  # turn on reporting:
  $DebugPreference = "Continue"
  # Your debugging reports will now be output
  # with the "DEBUG:" prefix and output in yellow:
  $result = Test

    DEBUG: Calculation will be performed
    DEBUG: Result will be emitted
    DEBUG: Done

  # They are not contained in the result:
  $result

    Result is: 120

  # Everything is running the way you wish;
  # turn off debugging:
  $DebugPreference = "SilentlyContinue"
  $result = Test
```

Write-Debug has a number of advantages. First, your debugging reports will be clearly marked and output in another color. Second, these reports will appear only if you expressly turn on the debugging mode. If your function is being used in a normal production environment, PowerShell will simply ignore the *Write-Debug* instruction. As a result, you won't have to take the trouble to remove your debugging output when the script is done.

Suppressing Error Messages

Errors cropping up inside your function normally cause error messages, and these error message will always be output immediately. So unlike normal output, error messages will not become part of the result of your function.

```
  Function Test
  {
    Stop-Process -name "Unavailableprocess"
  }
  # Normally error messages are always output immediately:
  $result = Test

    Stop-Process : Cannot find a process with the name
    "Unavailableprocess". Verify the process name and call
    the cmdlet again.
    At line:2 char:13
    + Stop-Process  <<<< -name "Unavailableprocess"
```

Obviously, this is very sensible because errors are not supposed to crop up, and if they do nevertheless, you should be alerted to their presence immediately. However, if you want to expressly make the error message "vanish" because you find it unimportant, turn off the error message output inside your function. But remember that from then on all error messages inside the function will no longer be generated:

```
Function Test
{
  # Suppress all error messages from now on:
  $ErrorActionPreference = "SilentlyContinue"
  Stop-Process -name "Unavailableprocess"
}
# All error messages inside the function are suppressed:
$result = Test
```

Of course, this is only wise if you're absolutely sure that you can afford to ignore the error. Even then, you shouldn't in general suppress errors inside your function, but only where it is really necessary so that you won't overlook other (and perhaps completely unexpected) errors:

```
Function Test
{
  # Suppress all error messages from now on:
  $ErrorActionPreference = "SilentlyContinue"
  Stop-Process -name "Unavailableprocess"
  # Immediately begin outputting all error messages again:
  $ErrorActionPreference = "Continue"
  1/$null
}
# Error messages will be suppressed in certain
# areas but not in others:
$result = Test

  Attempted to divide by zero.
  At line:5 char:3
  + 1/$ <<<< zero
```

It would be far better for you not to ignore errors in general. Instead, you should take note and respond to them. You'll learn more about this in Chapter 11.

Inspecting Available Functions

PowerShell already contains some predefined functions that you can access through *function*: PSDrive. If you would like to see all available functions use *Dir*:

```
Dir function:

  CommandType    Name           Definition
  -----------    ----           ----------
  Function       prompt         'PS ' + $(Get-Location) + $(If ($nested...
  Function       TabExpansion   param($line, $lastWord) &amp;{...
  Function      Clear-Host    $spaceType = [System.Management.Automat...
  Function      more          param([string[]]$paths);  If(($paths -n...
  Function      help          param([string]$Name,[string[]]$Category...
  Function      man           param([string]$Name,[string[]]$Category...
  Function      mkdir         param([string[]]$paths); New-Item -type...
  Function      md            param([string[]]$paths); New-Item -type...
  Function      A:            Set-Location A:
  Function      B:            Set-Location B:
  (...)
```

The result will tell you not only the names of functions but also their contents, which will be in the Definition column. If you would like to examine the definition of a particular function more closely, then directly access the function:

```
$function:prompt

 'PS ' + $(Get-Location) + $(If ($nestedpromptlevel -ge 1) { '>>' }) + '> '
```

Many of the predefined functions already perform important tasks in PowerShell. Let's now look a little more closely at a few examples:

Function	**Description**
Clear-Host	Deletes the screen buffer
help, man	Retrieves *get-help* internally and outputs help text one page at a time if you use the *-detailed* or *-full* switches
mkdir, md	Creates a new subdirectory using *New-Item*
more	Outputs either pipeline contents one page at a time or—if you specify one or more path names after *more*—the contents of specified files one page at a time
prompt	Returns prompt text
TabExpansio n	This function is called when you press (Tab) so that AutoComplete is activated. This tab completion mechanism uses the two variables *$line* and *$lastword*, in which you can find the line and the word requested for AutoComplete. Apart from the original Microsoft function *TabExpansion* supplied along with PowerShell, dedicated PowerShell users have developed numerous improved alternatives to enhance AutoComplete with many new options and functions.
X:	Invokes *Set-Location* for the specified drive letter. A pure alias

	could not accomplish this; functions can invoke cmdlets combined with arguments, while alias names cannot.

Table 9.1: Predefined PowerShell functions

tip

If you'd like to know how many functions are currently defined in your PowerShell environment, type:

```
(Dir Function:).Count
```

Prompt: A Better Prompt

Every time a command is successfully executed and the blinking cursor reappears, PowerShell invokes the *Prompt* function to receive new commands. In default setting, the prompt displays "PS", the path name of the current directory (retrieved by get-location), and after that one ">" or " >>" signs depending on whether the console is in normal mode or in a nested prompt. Because a publicly accessible function retrieves the prompt, you can make any changes you wish to the prompt. All you have to do is to reset the *Prompt* function. The relevant changes to the prompt will be made immediately:

```
Function Prompt { "Type something. >" }

  Type something. >
```

note

How do you get the old prompt back? When you change a function, the old function will be overwritten. You can't just get the old function back. However, all functions will be deleted the moment you end PowerShell. So, when you end and restart PowerShell, you'll get back your familiar prompt.

Of course, that raises the question of how you can permanently modify the prompt, as well as from where PowerShell actually got the original *Prompt* function. You can specify permanent changes to the functions in one of your PowerShell profiles, which contain scripts that are automatically executed after PowerShell starts. PowerShell also defines its own functions in profiles so that's where you can change them permanently. You'll find out more about profiles in Chapter 10.

Outputting Information Text at Any Location

Because the console contents are actually in the screen buffer, which you can access one line or character at a time, you also have the option of displaying additional information at any position in the screen buffer. The next function shows you how to do that. Access the screen buffer by using *$host.ui.rawui*. The *CursorPosition* function will furnish the current position of the blinking cursor as X (column) and Y (line). The function will note the current position in *$curPos* and specify the new position as an additional 60 characters to the right. Then it relocates the cursor at the new position and outputs the time and date. Finally, the old cursor position is restored so that the prompt reappears at its usual location:

```
function prompt
{
  $curPos = $host.ui.rawui.CursorPosition
  $newPos = $curPos
  $newPos.X+=60
  $host.ui.rawui.CursorPosition = $newPos
  Write-Host ("{0:D} {0:T}" -f (Get-Date)) `
    -foregroundcolor Yellow
  $host.ui.rawui.CursorPosition = $curPos
  Write-Host ("PS " + $(get-location) +">") `
    -nonewline -foregroundcolor Green
  " "
}
```

Using the Windows Title Bar

There is also room for information in the Windows console title bar where your prompt function could put useful information, such as the name of the user who is currently logged on or the current line. Use *$host.ui.rawui.WindowTitle* to set the text of the Windows title bar.

The next example specifies the name of the user who is currently logged on. We'll use the *GetCurrent* .NET static method to get the name from the *WindowsIdentity* object. Because invoking this function can consume several seconds of computing time and should not be executed again every time a new prompt is displayed, the user name is specified outside the function as a global variable:

```
$global:CurrentUser = `
  [System.Security.Principal.WindowsIdentity]::GetCurrent()
function prompt
{
  $host.ui.rawui.WindowTitle = "Line: " `
    + $host.UI.RawUI.CursorPosition.Y + " " `
    + $CurrentUser.Name + " " + $Host.Name `
    + " " + $Host.Version
  Write-Host ("PS " + $(get-location) +">") `
    -nonewline -foregroundcolor Green
  return " "
}
```

important The example incidentally shows how long lines in particular can be split up into several shorter lines. If you type a backtick character ("`") at the end of a line, the line will be continued in the next line.

Administrator Warning

The *Prompt* function can also warn you if you're using PowerShell with elevated privileges. Use *WindowsPrincipal* to find out your current user identity to determine whether or not you currently have administrator privileges. You don't need to understand the .NET code. It will return a global variable in *$Admin* to you that contains *$true* if you have administrator rights.

This variable evaluates the *Prompt* function. If you're working with elevated privileges, the word "Administrator:" will appear in the Windows title bar and the ">" sign of the prompt will be displayed in red:

```
$CurrentUser = `
  [System.Security.Principal.WindowsIdentity]::GetCurrent()
$principal = new-object `
  System.Security.principal.windowsprincipal($CurrentUser)
$global:Admin = `
  $principal.IsInRole( `
  [System.Security.Principal.WindowsBuiltInRole]::Administrator)
Function prompt
{
  # Output standard prompt:
  Write-Host ("PS " + $(get-location)) -nonewline
  # The rest depends on whether you have admin rights or not:
  If ($admin) {
    $oldtitle = $host.ui.rawui.WindowTitle
    # "Administrator: " displayed in title bar
    # if its not already included:
    If (!$oldtitle.StartsWith("Administrator: ")) {
     $host.ui.rawui.WindowTitle =
     "Administrator: " + $oldtitle
    }
    # End prompt in red:
    Write-Host ">" -nonewline -foregroundcolor Red
  } Else {
    Write-Host ">" -nonewline
  }
  return " "
}
```

Clear-Host: Deleting the Screen Buffer

No doubt, you've already noticed that the *cls* command deletes the screen buffer. In fact, *cls* is actually only an alias for the *Clear-Host* function. At first, though, you can't see the contents of this function:

```
$function:Clear-Host

  You must provide a value expression on
  the right-hand side of the "-" operator.
  At line:1 char:17
  + $function:clear-h <<<< ost
```

The "-" sign is a special character for PowerShell and, as always, if names contain special characters, put the entire expression in braces (remove line breaks to collapse to one line):

```
${function:Clear-Host}
$spaceType = [System.Management.Automation.Host.BufferCell];
$space = [System.Activator]::CreateInstance($spaceType);
$space.Character = ' ';
$space.ForegroundColor = $host.ui.rawui.ForegroundColor;
$space.BackgroundColor = $host.ui.rawui.BackgroundColor;
$rectType = [System.Management.Automation.Host.Rectangle];
$rect = [System.Activator]::CreateInstance($rectType);
$rect.Top = $rect.Bottom = $rect.Right = $rect.Left = -1;
$Host.UI.RawUI.SetBufferContents($rect, $space);
$coordType = [System.Management.Automation.Host.Coordinates];
$origin = [System.Activator]::CreateInstance($coordType);
$Host.UI.RawUI.CursorPosition = $origin;
```

This function is very hard to read because it has been written as one long one-liner. The function could be read better in this way:

```
$spaceType = [System.Management.Automation.Host.BufferCell]
$space = [System.Activator]::CreateInstance($spaceType)
$space.Character = ' '
$space.ForegroundColor = $host.ui.rawui.ForegroundColor
$space.BackgroundColor = $host.ui.rawui.BackgroundColor
$rectType = [System.Management.Automation.Host.Rectangle]
$rect = [System.Activator]::CreateInstance($rectType)
$rect.Top = $rect.Bottom = $rect.Right = $rect.Left = -1
$Host.UI.RawUI.SetBufferContents($rect, $space)
$coordType = [System.Management.Automation.Host.Coordinates]
$origin = [System.Activator]::CreateInstance($coordType)
$Host.UI.RawUI.CursorPosition = $origin
```

It doesn't make much sense to customize the *Clear-Host* function because what it is supposed to do —clearing the console contents—it does well. Nevertheless, you could easily override the function:

```
function Clear-Host { }
cls
```

Because *Clear-Host* is now "empty" and isn't doing anything, you won't be able to delete the screen contents any more—not even by using *cls*, because this alias will internally invoke the same function. To get back *Clear-Host*, restart PowerShell.

Predefined Functions Once Again: A:, B:, C:

The list of functions shows that even drive letters are independent functions. How could that be? And, above all: *when* can that be? Let's first look at what the function D: is actually doing:

```
${function:D:}

  Set-Location D:
```

The function does nothing other than switch over to the "*D:*" drive, much like *Cd d:*. But now the question arises: just when is that doing? Or, in other words: when does PowerShell actually invoke the *D:* function? If you type "*D:*", for example, after a statement, this entry will be interpreted as normal text. That means the built-in *D:* function will not be invoked:

```
Write-Host D:
D:
Dir D:
```

Only when "*D:*" itself becomes a statement, for example, because the term is the first in a line, or because the term is a sub-expression in parentheses, the *D:* function will be executed:

```
PS C:\> Dir (D:)


  Directory: Microsoft.PowerShell.Core\FileSystem::D:\
  Mode          LastWriteTime    Length Name
  ----          -------------    ------ ----
  d----    08.03.2007  16:17              M
  d----    07.26.2007  10:29             n1
  d----    07.26.2007  09:16            nst

PS D:\>
```

The astonishing result: the *D:* function is invoked and switches over first to the *D:* drive. *Dir* then lists the current drive, that is, *D:*. In conclusion, *D:* remains the current drive. That means that within a line you have not only changed the current drive, but also then listed this drive. But that's not really so spectacular because usually what is enclosed in parentheses is executed first, and you could also have typed the following in them:

```
Dir (Cd e:)
```

X: functions are interesting more for the reason that they show how you can access statements along with arguments under new and concise names. Aliases like *Cd* (for *Set-Location*) can abbreviate unwieldy command names, but they can't predefine additional arguments. In contrast, functions can invoke other commands as well with predefined arguments. They are designed to ensure that by simply typing a drive name you can switch to that drive just like you would when using the older console:

```
# Actually, a function is being invoked here:
e:
Dir
```

Functions, Filters and the Pipeline

Can functions actually read and further process the results of other commands? They can, namely by the pipeline, which PowerShell uses to connect more than one command to each other (see Chapter 5). In Chapter 5, you learned that the pipeline can command two modes: a slow sequential mode and a rapid streaming mode. In which of the two modes the pipeline can operate really depends on the statements used in the pipeline, and how you define your functions.

The Slow Sequential Mode: $input

In the simplest case, your function doesn't really support the pipeline. Your function is limited merely to processing the results of the preceding pipeline command if the command has completed its work. The results of the preceding command are always in the *$input* automatic variable. *$input* is an array: depending on the circumstances, it can contain many elements, exactly one element, or no element at all.

In the simplest case, a function will merely output the contents of *$input* again:

```
Function output
{
  $input
}
# The function, when invoked alone,
# will return nothing because no pipeline
# results are available:
output
# If you create an array in the pipeline,
# the function will output the array:
1,2,3 | output

  1
  2
  3

# The function is completely indifferent to
# which type of data is in the pipeline:
Dir | output

      Directory: Microsoft.PowerShell.Core\FileSystem::
        C:\Users\Tobias Weltner
  Mode        LastWriteTime    Length Name
```

```
    ----        -------------    ------ ----
    d----   07.20.2007  11:37           Application Data
    d----   07.26.2007  11:03           Backup
    d-r--   04.13.2007  15:05           Contacts
    (...)
```

Up to now, the function has merely output the pipeline results, and the result wasn't exactly spectacular. In the next step, the function should process each pipeline result separately. We want to create a function called *MarkEXE*, which will inspect the result of *Dir* and highlight executable programs having the ".exe" file extension in a red color:

```
Function MarkEXE
{
  # Note old foreground color
  $oldcolor = $host.ui.rawui.ForegroundColor
  # Inspect each pipeline element separately in a loop
  Foreach ($element in $input) {
    # If the name ends in ".exe", change the foreground color to red:
    If ($element.name.toLower().endsWith(".exe")) {
      $host.ui.Rawui.ForegroundColor = "red"
    } Else {
      # Otherwise, use the normal foreground color:
      $host.ui.Rawui.ForegroundColor = $oldcolor
    }
    # Output element
    $element
  }
  # Finally, restore the old foreground color:
  $host.ui.Rawui.ForegroundColor = $oldcolor
}
```

When you pass on the result of *Dir* to this function, you will immediately receive directory listings in which executable programs are listed in red:

```
Dir $env:windir  | MarkEXE
```

Filter: Rapid Streaming Mode

The slow sequential mode of the pipeline that you became accustomed to can be a problem when you have to process large quantities of data, resulting in enormous memory consumption and waiting periods. If your function supports the rapid streaming mode of the pipeline, in which the results of preceding commands are processed in real time while using minimal memory, then all you need is a little trick: use the *Filter* keyword instead of the *Function* keyword.

You would actually just need to replace the first "function" keyword by "filter" in your *MarkEXE* function, and it would begin to use the rapid streaming mode right away. Now, without having to endure long waits and the risk of a crash, you could use your filter to process recursive directory listings, even extremely lengthy ones:

```
Dir c:\ -recurse | MarkEXE
```

While your *MarkEXE* would be invoked only a single time, after *Dir* has done its work, the *MarkEXE* filter would be invoked again and again for every single element. For filters, *$input* always contains only a single result. That's why *$input* in filters is not useful at all. It's better for you to use the *$_* variable in filters because it contains the current result of the preceding command immediately. That simplifies code because from then on you no longer need any more loops:

```
Filter MarkEXE {
  # Note old foreground color
  $oldcolor = $host.ui.rawui.ForegroundColor
  # The current pipeline element is in $_
  # If the name ends in ".exe", change
  # the foreground color to red:
  If ($_.name.toLower().endsWith(".exe")) {
    $host.ui.Rawui.ForegroundColor = "red"
  } Else {
    # Otherwise, use the normal foreground color:
    $host.ui.Rawui.ForegroundColor = $oldcolor
  }
  # Output element
  $_
  # Finally, restore the old foreground color:
  $host.ui.Rawui.ForegroundColor = $oldcolor
}
```

Developing Genuine Pipeline Functions

Filters are superior to normal functions in pipelines because they immediately process every single result of the preceding command and don't have to wait until the preceding command has completed all its tasks. However, filters must be invoked repeatedly for every single result of the preceding command. That's difficult because certain tasks, like initialization or tidying, have to be carried out again every single time the filter is invoked. The *MarkEXE* function, for example, notes the current console foreground color when it begins and restores it when it finishes. The filter would then have to perform this task repeatedly for every single result of the preceding command. That costs time and resources.

In reality, filters are nothing more than special functions. If a function is used inside a pipeline, then you can define three fundamentally different task areas: the first initialization in which the function completes preparatory steps; the processing of each single result that traverses the pipeline from the preceding command; and the tidying chores at the end. These three task areas can be defined in functions by using *begin*, *process* and *end* blocks.

It turns into a filter as soon as a function defines at least the *process* block. A filter is nothing more than a function with a process block. Unlike a filter, a function, can also define *begin* and *end* block. That's why the following *MarkEXE* function is, of all our examples, the most efficient approach because the initialization and cleanup tasks need to be performed only once:

```
Function MarkEXE {
  begin {
    # Note old foreground color
    $oldcolor = $host.ui.rawui.ForegroundColor
  }
```

```
    process {
      # The current pipeline element is in $_
      # If the name ends in ".exe", change
      # the foreground color to red:
      If ($_.name.toLower().endsWith(".exe")) {
        $host.ui.Rawui.ForegroundColor = "red"
      } Else {
        # Otherwise, use the normal foreground color:
        $host.ui.Rawui.ForegroundColor = $oldcolor
      }
      # Output element
      $_
    }
    end {
      # Finally, restore the old foreground color:
      $host.ui.Rawui.ForegroundColor = $oldcolor
    }
  }
```

note

The next example will show that a filter is actually only a normal function that has a *process* block. First, it defines a filter:

```
filter Test { "Output: " + $_ }
```

Let's look now at the definition of the filter:

```
$function:Test

  process {
  "Output: " + $_
  }
```

PowerShell has translated its filter instruction into a normal function and set the code in a *process* block. Therefore, filters are functions that have a *process* block; nothing more.

Summary

Functions bring together one or more PowerShell commands under one name. If a function is invoked, it will execute the commands defined in it one after the other.

PowerShell uses this concept for internal purposes too; that's why it comes equipped with a number of predefined functions (see Table 9.1). You may modify these predefined functions if you'd like to change how PowerShell behaves.

You have the freedom of creating your own additional functions. For example, you can invent your own convenient shorthand for tasks that would otherwise require the execution of several steps or statements. In the simplest case, specify the name of your new function after the *Function* keyword and append the commands in braces that are supposed to carry out the function.

Functions will be more flexible if you pass them arguments that include additional information telling the function precisely what it is to do. The function can either access these arguments through the *$args* variable or define its own parameters. The arguments will then be automatically assigned to these parameters ("parameter binding") and all the arguments that might be left over will turn up again in *$args*. The parameters of a function can also be typed (in which case they will accept only a particular data type), and they may contain default values. Default values can also consist of PowerShell commands.

The result of a function includes everything that the function has output anywhere within its code. Therefore, a function can return zero results, exactly one result, or very many results. As soon as the result consists of more than one value, the function wraps it automatically in an array. It remains unaltered by the optional *return* statement, which merely has the purpose of exiting a function ahead of time.

In the PowerShell pipeline, functions also play a role in that they have the option of reading the results of the preceding command and processing them further. The results of the preceding command are in the *$input* variable. A function can implement the *process* block so that functions will not have to wait until the preceding command has completely carried out its work. This block will immediately step through every single result of the preceding command, and the respective result of the preceding command will then be provided in the *$_* variable. *Filter* functions exactly like functions with a *process* block. In addition, functions can implement a *begin* and *end* block, which runs just once respectively and serves the purpose of executing preparatory and follow-up tasks.

CHAPTER 10.

Scripts

PowerShell scripts function like batch files in the traditional console: scripts are text files that can include any PowerShell code. If you run a PowerShell script, PowerShell will read the instructions in it, and then execute them. As a result, scripts are ideal for complex automation tasks. In this chapter, you'll learn how to create and execute scripts.

PowerShell makes certain requirements mandatory for their execution because scripts can contain potentially dangerous statements. Depending on the security setting and storage location, scripts must have a digital signature or be specified with their absolute or relative path names. These security aspects will also be covered in this chapter.

Topics Covered:

Writing and Starting PowerShell Scripts

A PowerShell script is nothing more than a text file containing PowerShell code. If the text file is executed, PowerShell steps through its statements and executes them. PowerShell scripts work very much like the batch files of older consoles: you can create PowerShell scripts with much the same simplicity you could using batch files.

Using Redirection to Create Scripts

If your script is short, you could create it directly from within the console by redirecting the script code to a file:

```
' "Hello world" ' > myscript.ps1
```

But because you must use quotation marks to enclose text, it can be confusing to use quotation marks inside the script code. Or you may like to specify multi-line text. So, using "here-strings" would work better in this example:

```
@'
"Hello world"
"One more line"
Get-Process
Dir
'@ > myscript.ps1
```

Here-strings always begin with *@'* and end with *'@*. Everything in between is stored as text, including all special characters and line breaks. If you use double instead of single quotation marks, PowerShell will expand all variables in your here-string.

Creating Scripts with an Editor

Considerably more convenient are genuine text editors, such as Notepad. Assign it the task of creating a new file:

```
Notepad myscript.ps1
```

Notepad will open and offer to create the *myscript.ps1* file. Click *Yes*. Now you can write your script in Notepad. Just enter the same statements in Notepad that you would otherwise have typed interactively in the console:

```
"Howdy!"
```

Then use *File/Save* to save your script and close the Notepad.

Starting Scripts

While your script was created, it can't be started just like that. If you enter the file name of your script file, you'll get an error message:

```
myscript.ps1

  The term "myscript.ps1" is not recognized as a
  cmdlet, function, operable program, or script file.
  Verify the term and try again.
  At line:1 char:14
  + myscript.ps1 <<<<
```

It won't work until you specify at least the relative path name of the script, which is *.\myscript.ps1*:

```
.\myscript.ps1

  Howdy!
```

Execution restrictions

PowerShell always initially prohibits scripts from running. Whether scripts can be started or not is determined by the *execution policy*:

```
.\myscript.ps1

  File "C:\Users\Tobias Weltner\myscript.ps1"
  cannot be loaded because the execution of scripts
  is disabled on this system. Please see "get-help
  about_signing" for more details.
  At line:1 char:16
  + .\myscript.ps1 <<<<
```

Only an administrator can change this setting. The *Get-ExecutionPolicy* cmdlet will tell you the current setting of your execution policy:

```
Get-ExecutionPolicy

  Restricted
```

If you want to run scripts, choose another setting from Table 10.1 for the execution policy and use *Set-ExecutionPolicy* to specify it. You just need to change this setting once. PowerShell will make a permanent note of it.

Setting	**Description**
Restricted	Script execution is absolutely prohibited.
Default	Standard system setting normally corresponding to "Restricted".
AllSigned	Only scripts having valid digital signatures may be executed. Signatures ensure that the script comes from a trusted source and has not been altered. You'll read more about signatures later on.
RemoteSigned	Scripts downloaded from the Internet or from some other "public" location must be signed. Locally stored scripts may be executed even if they aren't signed. Whether a script is "remote" or "local" is determined by a feature called Zone Identifier, depending on whether your mail client or Internet browser correctly marks the zone. Moreover, it will work only if downloaded scripts are stored on drives formatted with the NTFS file system.
Unrestricted	PowerShell will execute any script.

Table 10.1: Execution policy setting options

Usually, the best "liberal" setting is *RemoteSigned* because you can run your own locally stored scripts and potentially dangerous scripts downloaded from the Internet are not allowed:

```
Set-ExecutionPolicy RemoteSigned
.\myscript.ps1

  Howdy!
```

tip

If you want PowerShell to run only those scripts that you approve, you can sign your scripts digitally. You'll find out how to do that at the end of this chapter. The *RemoteSigned* setting requires that all the scripts you download from the Internet must be signed. If you select *AllSigned*, this will apply to local scripts as well. Digital or Authenticode signatures are an excellent means for firms to provide a "stamp of quality" for their PowerShell scripts. They allow only verified and authorized scripts while preventing the execution of potentially hazardous scripts from unknown sources.

Invoking Scripts like Commands

To actually invoke scripts just as easily as normal commands—without having to specify relative or absolute paths and the ".psl" file extension—you can employ two simple tricks. The simplest is alias names. You could define a new alias name for invoking a script:

```
Set-Alias dosomething .\myscript.ps1
```

You could immediately launch you script by entering the *dosomething* command:

```
dosomething

  Howdy!
```

However, this alias would only work in the same directory in which the script is stored because it uses a relative path name. If you store your scripts in fixed locations, you'd better specify an absolute path name or use environment variables. You could put your script in a central directory and in a profile for all users:

```
md $env:appdata\PSScripts


  directory: Microsoft.PowerShell.Core\FileSystem::
  C:\Users\Tobias Weltner\AppData\Roaming
  Mode      LastWriteTime   Length Name
  ----      -------------   ------ ----
  d----   09.14.2007 10:00         PSScripts
```

Then copy the script to this directory:

```
copy myscript.ps1 $env:appdata\PSScripts\myscript.ps1
```

Now, specify a fixed destination path independently of the current directory:

```
Set-Alias dosomething $env:appdata\PSScripts\myscript.ps1
```

Alternatively, you could declare the directory in which your scripts are stored as a trusted location: include this directory in the Windows *Path* environment variable. All PowerShell scripts in this directory will no longer require you to specify them by using relative or absolute path names. You no longer even have to append the "ps1" file extension in this connection. Try it out:

```
# Create a directory for your scripts
md c:\PSScripts

  Directory: Microsoft.PowerShell.Core\FileSystem::C:\
  Mode      LastWriteTime Length Name
  ----      ------------- ------ ----
  d----   09.14.2007 10:08        PSScripts

# Copy the script under another name to this directory
copy myscript.ps1 c:\PSScripts\myscript.ps1
# Invoking failed:
myscript

  The term "myscript" is not recognized as a
  cmdlet, function, operable program or script
  file. Verify the term and try again.
  At line:1 char:4
  + myscript <<<< 100

# Include the directory in the PATH environment variable:
$env:path += "; c:\PSScripts"
# Invoking succeeded:
myscript

  Howdy!
```

note

Changes to the Windows environment variable can be risky because they also can have an impact outside the PowerShell console. That's why PowerShell always stores changes to the Windows environment variable only temporarily for the current session. The modifications would be revoked after closing and reopening the PowerShell console.

If you want to make permanent changes to environment variables like *Path*, do it either outside the PowerShell console or, even better, re-define your preferred settings every time PowerShell starts. You could use profile scripts that run automatically when PowerShell starts. You'll learn about them in the next section.

Passing Arguments to Scripts

You can write scripts that interact with the user, who can then pass arguments to a script. That works for scripts just as it does for the functions in the last chapter. Let's look at how you can modify your first simple script so that its output is not an unchangeable text, but a welcome text that a user can modify.

$args Returns All Arguments

Arguments that you pass to a function or a script are located in the *$args* variable. To get your script to output the text that the user specifies after the script name when the script is invoked, make the appropriate changes to your script. First, load it back in Notepad as in the following example:

```
notepad myscript.ps1
```

Now, change your script in the Notepad and replace the lines in it with these:

```
"Hello, $args!"
```

Save the change and try out your modified script.

```
.\myscript.ps1

  Hello, !
```

The script works, but no text in particular was output. That's obvious because you haven't specified any arguments yet. So, try out the script with an argument:

```
# The argument is integrated into the text:
.\myscript.ps1 Tobias

  Hello, Tobias!
```

It works and everything that you specify after the script name will be passed as an argument to your script.

$args is an Array

The data you specify after your script when it is invoked are called *arguments*. PowerShell evaluates these arguments and uses spaces to separate each argument from the other, which explains why your script brings together several spaces in succession:

```
# Spaces separate arguments. Several spaces
# following each other are combined into one:
.\myscript.ps1 This   text   has   a   lot   of   spaces!

  Hello, This text has a lot of spaces!!
```

PowerShell has identified seven separate arguments from the data that follows your script. You'll find them all afterwards in *$args,* which is in reality an array. If you would like to use spaces in an argument, and avoid PowerShell interpreting them as separators, your argument must be enclosed in quotation marks:

```
# Text in quotation marks is understood as precisely one argument:
.\myscript.ps1 "This   text   has   a   lot   of   spaces!"

  Hello, This   text   has   a   lot   of   spaces!!
```

Now all the spaces are output.

Accessing Separate Arguments in $args

Because *$args* is an array, you could also process each element of the array separately. In Chapter 4, you familiarized yourself with arrays so you know now that you can access elements in an array through an index. So, your script might look like this if you'd like to process the first argument:

```
"Hello, $($args[0])!"
```

However,*$args[0]* can no longer be simply integrated into the output text because PowerShell resolves only simple variables. The entire expression must be wrapped in a direct variable *$(...)*. Save your script, and then look at how your script handles your arguments now:

```
# Arguments are separated by spaces. "Weltner"
# is the second argument and will not be output:
.\myscript.ps1 Tobias Weltner

  Hello, Tobias!

# If you'd like to use arguments with spaces,
# put them in quotation marks:
.\myscript.ps1 "Tobias Weltner"

  Hello, Tobias Weltner!
```

Using Parameters in Scripts

While*$args* is a simple way to pass user data to a script, it's entirely up to you to find out which argument the user specified and in which order. If the user didn't enter his arguments in exactly the same order you anticipated, the script will get muddled and may not interpret his arguments correctly. In addition, the user won't get any feedback from the script telling him which arguments are permitted or required.

In older script languages, a lot of effort was required to validate passed arguments and to allocate them properly. But PowerShell has this option and it works very much like the parameters of the functions in the last chapter. For functions, parameters specified in parentheses after the function name:

```
function Test($path, $name) {
  "The path is: $path"
  "The name is: $name"
}
Test "The path" "The name"

  The path is: The path
  The name is: The name

Test -name "The name" -path "The path"

  The path is: The path
  The name is: The name
```

This works exactly the same way for scripts, just that the question arises of where to put the parameters for a script. While functions are always located in a *function Name(Parameter) {...}* construct, such a framework isn't available for scripts. That's why scripts have to use the *param* statement.

Let's translate the function with the two parameters *$path* and *$name* into a script. Open your script again for processing in Notepad:

```
notepad myscript.ps1
```

Now type this code:

```
param($path, $name)

  "The path is: $path"
  "The name is: $name"
```

Save your script and try it out:

```
.\myscript.ps1 "the path" "the name"

  The path is: the path
  The name is: the name

.\myscript.ps1 -name "the name" -path "the path"

  The path is: the path
  The name is: the name
```

It works: your script responds now just like the function and uses parameters instead of unnamed arguments. The data in parentheses after *param* exactly match the same data that you put after the function names in parentheses for functions.

Validating Parameters

After reading the last chapter, you should know how to formulate arguments so that PowerShell can verify that they were specified. The next script requires an argument called *name* and another called *age*. It establishes exactly which data type is necessary for each argument and also determines that an error message will be output if the argument is not specified:

```
param([string]$Name=$( `
  Throw "Parameter missing: -name Name"),
  [int]$age=$( `
  Throw "Parameter missing: -age x as number")) `
  "Hello $name, you are $age years old!"
```

Save this script and execute it. If you forget to specify one of the two arguments, or if you specify the parameter with an invalid value, PowerShell will automatically output an appropriate error message:

```
# Parameter missing:
.\testscript.ps1

  Parameter missing: -name Name
  At C:\Users\Tobias Weltner\testscript.ps1:1 char:28
  + param([string]$Name=$(Throw  <<<< "Parameter
  missing: -name Name"), [int]$age=$(Throw
  "Parameter missing: -age x as number"))

# Parameter missing:
.\testscript.ps1 -name Tobias

  Parameter missing: -age x as number
  At C:\Users\Tobias Weltner\testscript.ps1:1 char:80
  + param([string]$Name=$(Throw "Parameter missing:
  -name Name"), [int]$age=$(Throw  <<<< "Parameter
  missing: -age x as number"))

# Parameter value is invalid:
.\testscript.ps1 -name Tobias -age willibald

  C:\Users\Tobias Weltner\testscript.ps1 : Cannot
  convert value "willibald" to type "System.Int32".
  Error: "Input string was not in a correct format."
  At line:1 char:37
  + .\testscript.ps1 -name Tobias -age  <<<< willibald

# Parameters are okay:
.\testscript.ps1 -name Tobias -age 212

  Hello Tobias, you are 212 years old!
```

pro tip

Strictly speaking, there are not *any* difference at all between functions and scripts. The statements in parentheses after the function name are also translated for functions into exactly the same *param* statement as they are for scripts. You can easily convince yourself that this is the case by typing the *Test* function in the preceding example and then outputting the source code of the function. You'll see that the function framework has vanished and the *param* statement is now in the script block:

```
$function:test
param($path, $name) "The path is: $path"
  "The name is: $name"
```

Scopes: Ranges of Validity in Scripts

To prevent scripts from having unintentional effects on other scripts or their interactive consoles, they are usually executed in isolation. Here, "isolation" means that all the variables and functions you create in a script are valid only inside the script. If you want to remove isolation, you can "dot source" scripts and functions when you invoke them: this just means putting a single dot or period in front of scripts and functions when you call them. If you want to define the scope of each variable or function separately, use the identifiers described in Chapter 3.

PowerShell stores all the variables in the interactive console in the *global:* area. All the variables that a script creates are stored in the *script:* area. When a script has completed its work, its *script:* area is deleted. That's how PowerShell removes only the variables that the script created. Variables that are already there remain untouched because of their location in the *global:* area.

This raises an interesting question of how scripts handle variables that have already been defined previously. If a variable doesn't exist in the current scope, PowerShell will try to find it in the parent scope. So, if you created a variable called *$test* in the console, your script would be able to read this variable. However, change is constant in the current scope: if you modify the contents of the *$test* variable inside your script, PowerShell would create a new variable called *$test* in the *script:* area. The result would be two variables: one in the *global:* area and one in the *script:* area. Your script would use the new variable because when you invoke *$test* inside the script, PowerShell will always look in the current scope first and will not proceed to the parent scope until it cannot locate the sought word. The script can read this variable since *$test* was created in the current scope. Here's a little test script:

```
"Variable contents: $test"
$test = "modified"
"Variable contents: $test"
```

Take a look at how the script handles the *$test* variable:

```
# Invoke your script:
.\myscript.ps1
# The $test variable was not defined in the
# global area, and so it is empty:
```

```
Variable contents:
# Then the script modifies $test and uses its
# own version in the script: area:

  Variable contents: modified

# We will now set a value for $test in the
# global area and restart the script
$test = "default"
.\myscript.ps1
# The script finds the value in $test that was
# set outside the script:

  Variable contents: default

# The script can change the value of $test,
# so it uses its own version in the script:

  Variable contents: modified

# As soon as the script ends, $test regains
# the old value because the script:
$test

  default
```

tip

You are free to specify which variable store (or area) you want to access by typing the requested area in front of the variable name. In this way, it is entirely possible for a script to make permanent variable changes that will continue to exist after the script is ended. To see how that works, change your script as follows and take another look at the results afterwards:

```
$test = "default"
# Create a script:
@' "default contents: $test";
$global:test = "modified";
"Variable contents: $test" '@ > myscript.ps1
# Execute a script:
.\myscript.ps1

  Variable contents: default
  Variable contents: modified

$test

  modified
```

You'll find more details on directly accessing the variable store in Chapter 3. However, in practice it's often sufficient to decide whether a script should be generally isolated or not isolated.

#requires: Script Requirements

Scripts may have certain requirements for their execution. Cmdlets are not necessarily limited to just the ones included in PowerShell. Third-party suppliers offer additional cmdlets. For example, if you're using *Microsoft Exchange* you'll have many additional special Exchange cmdlets at your disposal.

The cmdlets are part of an additional snap-in that Exchange includes. All additional snap-ins are loaded on the basis of an automatically starting profile script by using *Add-PSSnapin*. *Get-PSSnapin* can show you which snap-ins are currently in use by your PowerShell console:

```
get-pssnapin

  Name        : Microsoft.PowerShell.Core
  PSVersion   : 1.0
  Description : This Windows PowerShell snap-in contains Windows
                PowerShell management cmdlets used to manage
  components of Windows PowerShell.
  Name        : Microsoft.PowerShell.Host
  PSVersion   : 1.0
  Description : This Windows PowerShell snap-in contains cmdlets
                used by the Windows PowerShell host.
  Name        : Microsoft.PowerShell.Management
  PSVersion   : 1.0
  Description : This Windows PowerShell snap-in contains management
                cmdlets used to manage Windows components.
  Name        : Microsoft.PowerShell.Security
  PSVersion   : 1.0
  Description : This Windows PowerShell snap-in contains cmdlets to
                manage Windows PowerShell security.
  Name        : Microsoft.PowerShell.Utility
  PSVersion   : 1.0
  Description : This Windows PowerShell snap-in contains utility
                Cmdlets used to manipulate data.
```

If a script uses commands from an additional snap-in, it can indicate that by using the *#requires* statement. For example, specify a snap-in after *#requires* that is essential for the script. If the snap-in is missing, PowerShell won't start the script and will instead output an error message. This is how such a script might look:

```
#requires -PSSnapin Microsoft.PowerShell.Host
#requires -PSSnapin something.unavailable
"It worked"
```

While the first requirement appears to be met because this snap-in is part of the basic snap-ins, the second required snap-in is missing. If you try to run the script, you'll get an error message informing you why the script couldn't be started:

```
.\test1.ps1

  The script 'test1.ps1' cannot be run because the following
  Windows PowerShell snap-ins that are specified by its
  "#requires" statements are missing: something.unavailable.
  At line:1 char:11
  + .\test1.ps1 <<<<
```

If you want to lock in a script to a particular version of PowerShell, use the *-Version* parameter. Scripts that use new V2-specific features will be able to use *#requires -Version 2* to specify that they can't be run with the older version.

Note that you are able to use *-ShellID* to limit execution of scripts to particular PowerShell consoles. *-ShellID* is a PowerShell console identifier and is located in the *$ShellID* automatic variable. For the Microsoft console, the tag is *Microsoft.PowerShell*. Use *#requires -ShellID Microsoft.PowerShell* if you'd like to ensure that a script may be executed in Microsoft consoles only.

Making Scripts Understandable

Scripts may be as long as you'd like but typically the longer a script is, the harder it will be to read it. For this reason, lengthy scripts use two methods to keep script code understandable:

- **Functions:** Consolidate smaller tasks in functions, which not only make code easier to grasp but can also be reused conveniently. Once you've created a function for a certain task, you can use it later in other scripts as well.
- **Libraries:** Embed required functions as a library into your script so you won't need to copy your basic functions into every script, inflating them artificially. Your basic functions can remain in a single script while your current script focuses on just the one task it needs to complete.

Using Functions in Scripts

To be able to use a function inside a script, simply insert the function into the script code. Look at a lengthier script to see how this is done. Open Notepad again:

```
notepad net.ps1
```

Then enter the following script and save it:

```
param ([double]$amount = $(Throw "You have to specify a sum."))
$tax = VAT($amount)
$total = $amount + $tax
"{1:C} VAT is payable on the amount of {0:C}: {2:C}" `
  -f $amount, $tax, $total
function VAT($net)
```

```
{
  $factor = 0.19
  $net * $factor
}
```

This script uses *param* first to define the *amount* parameter because the script is supposed to calculate the value-added tax payable on a net sum. The script utilizes the strong type specification we saw in Chapter 3 to set the *amount* parameter as a floating point number (type: *double*). If the user doesn't name a number, an error message will be generated.

```
.\net.ps1

  You have to specify a sum.
  At C:\Users\Tobias Weltner\net.ps1:1 char:33
  + param ([double]$amount = $(Throw  <<<<
  "You have to specify a sum."))
```

If you then specify a sum, the script will generate an error message anyway and will return an incorrect result:

```
.\net.ps1 100

  The term "VAT" is not recognized as a cmdlet,
  function, operable program, or script file.
  Verify the term and try again.
  At C:\Users\Tobias Weltner\net.ps1:3 char:15
  + $tax = VAT( <<<< $amount)
  VAT is payable on the amount of $100.00: $100.00
```

Apparently, the script couldn't locate the *VAT* function. Unlike most other script languages, PowerShell functions that you define inside your script must be at the *beginning* of your script. The functions come into play only after PowerShell has read and created the functions with PowerShell reading scripts rigidly from top to bottom. So, a correctly written script should look like this:

```
param ([double]$amount = $(Throw "You have to specify a sum."))
function VAT($net)
{
  $factor = 0.19
  $net * $factor
}
$tax = VAT($amount)
$total = $amount + $tax
"{1:C} VAT is payable on the amount of {0:C}: {2:C}" `
  -f $amount, $tax, $total
```

After this transposition, the script now works as expected:

```
.\net.ps1 100

  $19.00 VAT is payable on the amount of $100.00: $119.00
```

Separating Scripts into Work Scripts and Libraries

Genuine scripts developed to solve practical problems usually include many more than just one function. The scripts may become unclear when function definitions pile up at the beginning of scripts. Functions, once you have created, tested, and approved them, should really not be eye-catching. Prevent that by using script libraries. Save your functions in a separate script file for later inclusion in all your scripts. The scripts can then use the functions saved in the file. Try it out. First, create a script library:

```
notepad calcfunctions.ps1
```

Then, enter this function in Notepad and save the script:

```
function VAT($net)
{
  $factor = 0.19
  $net * $factor
}
```

After this step, create a work script. The work script shouldn't include any general functions. Instead, it simply loads the functions it requires from the script library.

```
notepad net.ps1
```

Enter the following code and save the script:

```
param ([double]$amount = $(Throw "You have to specify a sum."))
# Functions will be loaded dot sourced from the library:
. .\calcfunctions.ps1
$tax = VAT($amount)
$total = $amount + $tax
"{1:C} VAT is payable on the amount of {0:C}: {2:C}" `
  -f $amount, $tax, $total
```

The work script will execute the script with the functions first, and then this script will create the required functions. Note that all variables and functions that create a script are as a rule "private" and are valid only within the script. That's critical because scripts must not have unintentional effects on each other. However, because in this case you want the library script to affect the work script (namely by creating new functions that will be disclosed in the work script), the "dot sourced" library script will be invoked: a single dot will be placed in front of the invoked script. The dot will cancel script isolation, and all the functions that the library script creates will also be valid in your work script.

This method is enabling you to load any number of script libraries in your work script. The result is that your work script stays clear and concise while the functions in the libraries can be developed separately.

- **Work script:** work scripts shouldn't include any general functions, just the code needed to perform current tasks. Required functions are implemented from external scripts. These must be called by using dot sourcing.

- **Library:** libraries may contain only function definitions and no code except for function definitions because the code would otherwise be immediately executed when the library is reloaded.

Library Scripts Central Directory

You should work out a strategy for optimal storage of library scripts as soon as you start using library scripts in your work scripts. One option would be to store the library scripts in the same directory as the work scripts. That way your work scripts could always access its library scripts over a relative path specification, as seen in the preceding example. Another option would be to copy your work scripts to another location, but in then you would have to remember to copy your library scripts as well.

If you'd prefer to store your library scripts in a central location because you want to deny general access to them, or because the library scripts should be stored in a directory that grants users authorization to read them only, and then type absolute path names in your work script. Utilize environment variables to specify the directory where the library script is. If library scripts are in a user profile in the *PSLib* directory, you could modify your work script in the following way:

```
param ([double]$amount = $(Throw "You have to specify a sum."))
# Functions will be loaded dot sourced from the library:
. $env:appdata\PSLib\calcfunctions.ps1
$tax = VAT($amount)
$total = $amount + $tax
"{1:C} VAT is payable on the amount of {0:C}: {2:C}" `
  -f $amount, $tax, $total
```

You could use the following lines to create the *PSLib* directory in a user profile and to copy your locally stored library in this area to which all users could have access:

```
# Create a directory for commonly used script libraries:
md $env:appdata\PSLib


   directory: Microsoft.PowerShell.Core\FileSystem::
   C:\Users\Tobias Weltner\AppData\Roaming
   Mode        LastWriteTime  Length Name
   ----        -------------  ------ ----
   d----   14.09.2007  09:42         PSLib

# Copy the locally stored library to the central directory:
copy calcfunctions.ps1 $env:appdata\PSLib\calcfunctions.ps1
```

tip

Use the *$MyInvocation* automatic variable if you want to know where a script is stored from within a script, to give library scripts an absolute path name that are located in the same directory. Here's an example of a script, which when executed states its name and the directory where it is located:

```
function get-scriptname
{
   if ($myInvocation.ScriptName) { $myInvocation.ScriptName }
   else { $myInvocation.MyCommand.Definition; "second" }
}
$myPath = get-scriptname
$myPath
$myParent = split-path $myPath
$myParent
```

Creating Pipeline Scripts

PowerShell scripts can be used as building blocks in the pipeline just like functions, which were covered in the last chapter. Moreover, what applies to functions applies to scripts as well: depending on how you program the script, you can either force the pipeline to adopt the slow and memory-intensive sequential mode or enable the rapid streaming mode.

Slow Sequential Mode

If you use a script inside the pipeline, the script will collect the results of the preceding statement in the *$input* automatic variable. But the script also blocks up the pipeline because the pipeline has to wait first until the preceding statement has fully completed its task. Only then can the pipeline pass on its result in *$input* to the script. Try out a new test script:

```
notepad filter.ps1
```

Type this code:

```
Foreach ($element in $input)
{
  If ($element.name.contains(".exe"))
  {
    Write-Host -fore "red" $element
  }
  Else
  {
    Write-Host $element
  }
}
```

The script will read the results in *$input* and mark every line in red that includes the ".exe" term. The script functions flawlessly in the pipeline:

```
Dir $env:windir | .\filter.ps1
```

Long waiting periods occur because the script doesn't go into action until *Dir* has done its work. Moreover, because all the results of the preceding statement have to be stored temporarily first, memory consumption is extremely high and may even make Windows unstable:

```
Dir c:\ -recurse | .\filter.ps1
```

Quicker Streaming Mode

There are reasons why scripts used in the pipeline should support the rapid streaming mode. It works for scripts just as it does for functions: all you need to do is to define the *begin*, *process*, and *end* script blocks in your script. The code in the *begin* block will be executed once at the beginning and can carry out initialization tasks or output messages to the user. The code in the *process* block will be executed in real time for every incoming result of the preceding statement, and the code in the *end* block will be executed at the end. It could carry out cleanup chores or simply report that the operation is concluded. Your filter script would function in real time as follows:

```
begin
{
  "Evaluation is beginning... one moment, please."
}
process
{
  if ($_.name.contains(".exe"))
  {
    Write-Host -fore "Red" $_
  }
  else
  {
    Write-Host $_
  }
}
end
{
  "Evaluation is concluded."
}
```

tip

A normal script that doesn't implement any of the *begin*, *process* or *end* blocks will automatically get what amounts to an *end* block. However, you can't combine them. As soon as you insert one of the *begin*, *process* or *end* blocks in your script, no more script code may be left outside one of these blocks. If you do, you will receive an error message like this one:

```
No combined Begin/Process/End clauses with command
text could be processed. A script or a function can
decide over begin/process/end clauses or command
text, but not over both.
At C:\Users\Tobias Weltner\filter.ps1:23 char:9
+ "Done!" <<<<
```

Writing Pipeline Results

While your script did process the results of the preceding statement faultlessly, it ended the pipeline. That's wasn't as noticeable because no additional statements followed after your script in the pipeline. The reason: your script received the results of the preceding statement, processed them, and then used *Write-Host* to write them directly in the console. The results were therefore not passed on in the pipeline. That's OK if your script concludes the pipeline.

However, if you want to write an authentic pipeline script that not only receives pipeline data but hands them on to the next statement, you need to make sure that the processed data are subsequently put back into the pipeline. The next script does that by using a *Switch* condition to validate a number of file extensions. In this specific example, changing the characters of the names to upper case works:

```
begin
{
  Write-Host " Evaluation is beginning... one moment, please."
}
process
{
  $element = $_
  Switch($_.Extension.toLower())
  {
    ".ps1"  { $element.name.toUpper() }
    ".vbs"  { $element.name.toUpper() }
    ".txt"  { $element.name.toUpper() }
    ".xml"  { $element.name.toUpper() }
    default  { $element.name.toLower() }
  }
}
end
{
  Write-Host "Evaluation is concluded."
}
```

This script simply outputs the results in the *process* block to the pipeline. In this way, it allows the other following statements to process the results. For this reason, you could use *Out-File* afterwards to wrap the results in a text file:

```
Dir | .\filter.ps1 | Out-File list.txt
.\list.txt
```

tip

Perhaps you noticed that the list includes only the file names and not the start and end messages of the script. As in the preceding example, *Write-Host* output these two messages. But *Write-Host* didn't output the file names. That shows the importance of the role Write-Host plays: use it for all messages that are supposed to appear immediately and never be redirected.

Profile: Autostart Scripts

Many changes you make in the PowerShell console are in effect for just a limited period of time. All alias definitions, functions, and changes to Windows environment variables are valid only until you close the PowerShell console. That's why you should use profiles to make basic changes permanent. Profiles are special scripts that PowerShell runs automatically when you start it. Locate all your initialization tasks in profiles so that PowerShell will always use exactly the configuration you want it to use when it starts.

Four Different Profile Scripts

On the whole, PowerShell supports four different profile scripts, which enable you to select a profile that fits your initialization tasks. The first question to ask is: should the initialization tasks apply to you personally or to all users? If you'd like the script to apply to you personally, use your own "current user" profile. However, if your statements are supposed to run for all users whenever PowerShell is started, the correct profile to use is "all users."

Profile	**Description**	**Location**
All users	Common profile for all users	*$pshome\profile.ps1*
All users (private)	Common profile for all users; valid only in powershell.exe	*$pshome\Microsoft.PowerShell _profile.ps1*
Current user	Current user profile	*$((Split-Path $profile -Parent) + "\profile.ps1")*
Current user (private)	Current user profile; valid only in powershell.exe	*$profile*

Table 10.2: PowerShell profiles

There are also "private" options for these two profiles. These only function if you use the Microsoft Windows PowerShell console. Are there others? Indeed there are. More and more companies are supporting PowerShell. Alternative consoles already exist that you could use instead of powershell.exe. Use the general profile if you'd like to have your modifications executed when PowerShell starts with applications developed by other companies. Use the private profile If you want your modifications to be executed only when using the original PowerShell console.

important

Table 10.2 lists the four PowerShell profiles and also tells you where each profile can be found. You might notice a PowerShell design weakness here: the private profile for the current user can be accessed easily by using the predefined variable *$profile*. That could lead to many users (and add-on developers) stored their extensions in this profile. However, because it is a private profile, it can only be run by the original Microsoft console. And that could become a problem right away if you switch to another company's PowerShell product.

For this reason, you should try not to use private profiles as much as possible so that you can be prepared for future developments. Use the general profile instead, even if it isn't quite so easy to control.

Creating Your Own Profile

Profiles aren't mandatory. That's why you might not have an available profile. You've already seen how easy it is create new PowerShell scripts and it's just as easy to create profile scripts

Perhaps you've created some useful alias shortcuts and would like these alias definitions to be automatically activated whenever PowerShell starts. You can achieve that by creating your own personal profile:

```
notepad $((Split-Path $profile -Parent) + "\profile.ps1")
```

This opens Notepad. It will show whether a profile already exists. If not, it will offer to create a new, empty script. Click *Yes*.

If a profile script already exists, you should inspect it first. In all probability it originates from some PowerShell extension or other that you downloaded and installed. In this case, simply add some statements to the script. For example, insert the following statement into the profile script to set up a new alias called *edit*, which will allow you to start Notepad conveniently:

```
Set-Alias edit notepad.exe
```

Save the script after that, and then close and reopen the PowerShell console. Your profile script will run invisibly in the background, and your new alias command will be created automatically. You can use it for convenient editing of PowerShell scripts:

```
edit $((Split-Path $profile -Parent) + "\profile.ps1")
```

Create a Global Profile for All Users

You can create global profile scripts that all system users can use just as easily by specifying the location of the "all users" profile:

```
  notepad $pshome\profile.ps1
```

Note that this is permitted only if you have administrator privileges. Otherwise, any user could manipulate the start of another user's console. If you aren't the administrator, Windows will deny you permission to store anything at this location.

Windows Vista is a special case. Even when you log on as administrator, Vista will deprive you of administrator status: you're a normal user, at least if you haven't turned off the User Account Control (UAC). Consequently, to create or work on a global profile, you must first activate your full administrator privileges. To accomplish that, don't start PowerShell by clicking in the normal way. Instead, use the right mouse button, and then select *Run as Administrator* in the shortcut menu. Your PowerShell console will run with full administrator privileges for all programs that you call from within the console, including the Notepad, which you could then use to modify the global profile.

pro tip

Some editors issue no problem reports if you work on the global profile without administrator privileges. Apparently, these editors have the capacity to make changes to the global profile, as shown by the fact that these changes go into effect when you restart PowerShell—and yet that's not security vulnerability. In reality, Windows Vista just deceives such editors. For compatibility reasons, Vista re-directs the attempt to modify the protected profile file to a hidden shadow area where editors can change profile files in whatever way they wish.

When PowerShell starts again the same thing happens: PowerShell processes the concealed shadow file instead of the protected profile file when no authentic global file is available. Could someone take advantage of this to foist a start script onto other users?

No, there's no risk. The hidden file actually exists only in the user profile of the user who created it. It has no effect on other users and basically behaves exactly like the user's private profile file. You can then find shadow file copies in this directory:

```
  Cd $env:localappdata\VirtualStore
```

The shadow copy of the global profile is located in the *Windows\System32\WindowsPowerShell\v1.0* subdirectory.

Digital Signatures for Your Scripts

Scripts can be easily faked or modified since they are simple text files. . Digital signatures provide greater security because they confirm the identity of the script author and guarantee that the script has not been altered since it was signed. To the extent that you trust the script publisher, you can be sure that nobody is trying to palm off malicious code on you. Even many experts don't completely understand how that works because these mechanisms are based on wickedly complex theories. Fortunately, in the practical world you need not concern yourself about these theories. What's important is that you familiarize yourself with the mechanisms and procedures. For this reason, all the important steps involved in using signatures will be embedded in easily understandable examples in the following sections.

Finding an Appropriate Certificate

Since it is hardly possible to use a classic fountain pen to sign PowerShell scripts (not to mention all other digital data), you'll need another instrument: a certificate as well as a private and secret key. The certificate is your electronic identity and is proof of who produced the signature. The private and secret key ensures that only the certificate owner can use the certificate to produce signatures.

So you're going to need a suitable certificate before you can digitally sign your own PowerShell scripts. The intended "code signing" purpose must be entered into the certificate and you'll also need a private and secret key for the certificate. PowerShell can find out whether certificates that meet these criteria are available on your computer system because all certificates are located in the *cert:* virtual drive:

```
Dir cert: -Recurse -codeSigningCert
    directory: Microsoft.PowerShell.Security\Certificate::CurrentUser\My

  Thumbprint                                 Subject
  ----------                                 -------
  E24D967BE9519595D7D1AC527B6449455F949C77   CN=PowerShellTestCert
```

The *-codeSigningCert* parameter ensures that only those certificates are located that are approved for the intended "code signing" purpose and for which you have a private and secret key.

In this case, just one certificate was found, but it could have been more or even none at all. If you have exactly one personal code-signing certificate, you could access it over this line:

```
Dir cert:\CurrentUser\My -codeSigningCert
```

note

What is the difference between *Dir cert:\CurrentUser\My* and *Dir cert:CurrentUser\My*? The answer: the first path specification is *absolute* and consequently always works no matter what your current directory. The second path specification is *relative* and will go amiss if you have set your current directory to a subdirectory of the certificate store. For this reason, always type a "\" character after *cert:*.

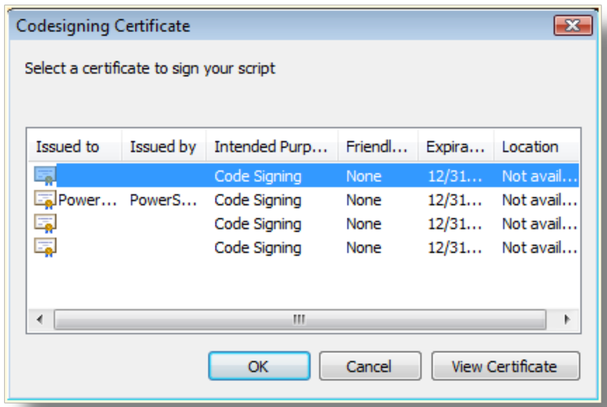
If you have a choice of several certificates, you have to narrow your choices down to one. In this example, you would specify the certificate name as your choice:

```
$certificate = Dir cert:\CurrentUser\My |
  Where-Object { $_.Subject -eq "CN=PowerShellTestCert" }
```

You can even use *SelectFromCollection()* to open an option dialog and easily select a certificate provided that you address the internal functions of the .NET framework from within PowerShell. But first you would have to use *LoadWithPartialName()* to load the *System.Security.dll* in advance:

```
$Store = New-Object `
system.security.cryptography.X509Certificates.x509Store( `
"My", "CurrentUser")
$store.Open("ReadOnly")
[System.Reflection.Assembly]::`
LoadWithPartialName("System.Security")
$certificate = `
[System.Security.Cryptography.x509Certificates.X509Certificate2UI]::`
SelectFromCollection($store.certificates, `
"Your certificates", "Please select", 0)
$store.Close()
$certificate

  Thumbprint                                Subject
  ----------                                -------
  372883FA3B386F72BCE5F475180CE938CE1B8674  CN=MyCertificate
```


Codesigning Certificate

Select a certificate to sign your script

Issued to	Issued by	Intended Purp...	Friendl...	Expira...	Location
		Code Signing	None	12/31...	Not avail...
Power...	PowerS...	Code Signing	None	12/31...	Not avail...
		Code Signing	None	12/31...	Not avail...
		Code Signing	None	12/31...	Not avail...

Figure 10.1: Using an option dialog to select a certificate

Creating a New Certificate

In most cases, you won't find any code-signing certificates on your computer so you'll have to obtain one from one of several sources:

- **Private:** Companies that run their own *Public Key Infrastructure* (PKI) will provide you with a private PKI. Typically, only business firms that have their own computing centers or universities can offer this option because a PKI is complex and expensive. Moreover, such certificates are usually valid within their own sphere of influence only.
- **Purchased:** Well-known and recognized certification companies like *VeriSign* or *Thawte* will be happy to sell you code-signing certificates in return for payment. You won't need your own private PKI, and such certificates are valid worldwide. However, the transaction is expensive and must usually be repeated regularly, such as every year. In addition, you have to go through elaborate procedures to prove your identity to the certifying enterprise.
- **Self-signed:**An individual certificate basically requires no complicated PKI. You can simply act as your own signing authority and issue one to yourself. You can then test and tinker with all aspects of the digital signature. Nobody will prevent you from using your own self-signed certificates productively. However, self-signed certificates are not managed by any certifying authorities. You are solely responsible for these certificates and their integrity. If a self-signed certificate lands in the wrong hands, nobody will be able to help you limit damages. For this reason, self-signed certificates are mostly used solely in testing environments and later replaced with certificates issued by a recognized PKI signing authority.

Creating Self-Signed Certificates

The key to making self-signed certificates is the Microsoft tool *makecert.exe*. Unfortunately, this tool can't be downloaded separately and it may not be spread widely. You have to download it as part of a free "Software Development Kit" (SDK). *Makecert.exe* is in the .NET framework SDK which you can find at*http://msdn2.microsoft.com/en-us/netframework/aa731542.aspx*.

After the SDK is installed, you'll find *makecert.exe* on your computer and be able to issue a new code-signing certificate with a name you specify by typing the following lines:

```
$name = "PowerShellTestCert"
pushd
Cd "$env:programfiles\Microsoft Visual Studio 8\SDK\v2.0\Bin"
.\makecert.exe -pe -r -n "CN=$name" -eku 1.3.6.1.5.5.7.3.3 -ss "my"
popd
```

It will be automatically saved to the *CurrentUser\My* certificate store. From this location, you can now call and use any other certificate:

```
$name = "PowerShellTestCert"
$certificate = Dir cert:\CurrentUser\My |
  Where-Object { $_.Subject -eq "CN=$name"}
```

Examining the Code-Signing Certificate

The code-signing certificate represents your digital identity. But let's first take a look at what the certificate "knows" about you. To do so, first call the certificate and store it in a variable:

```
# Call all code-signing certificates and store them in a field:
$certs = @(Dir cert:CurrentUser\My -codeSigningCert)
"{0} certificates were found." -f $certs.count
```

```
  3 certificates were found.

# Use the first certificate that was found:
$certificate = $certs[0]
# Who is represented by this certificate?
$certificate.subject

  CN=PowerShellTestCert

# Who issued this certificate?
$certificate.issuer

  CN=PowerShellTestCert
```

Declaring a Certificate "Trusted"

As you will quickly see, the certificate naturally contains only data than you specified yourself when creating the certificate. Even falsehoods are allowed. Nobody is going to prevent you from assuming someone else's identity when you create a certificate yourself. This means that certificates are not tamper-proof. The certificate itself "knows" this: if you use *Verify()* to check whether you can trust the data given in the certificate, PowerShell will respond with *False* in the case of self-signed certificates: the certificate is not trusted.

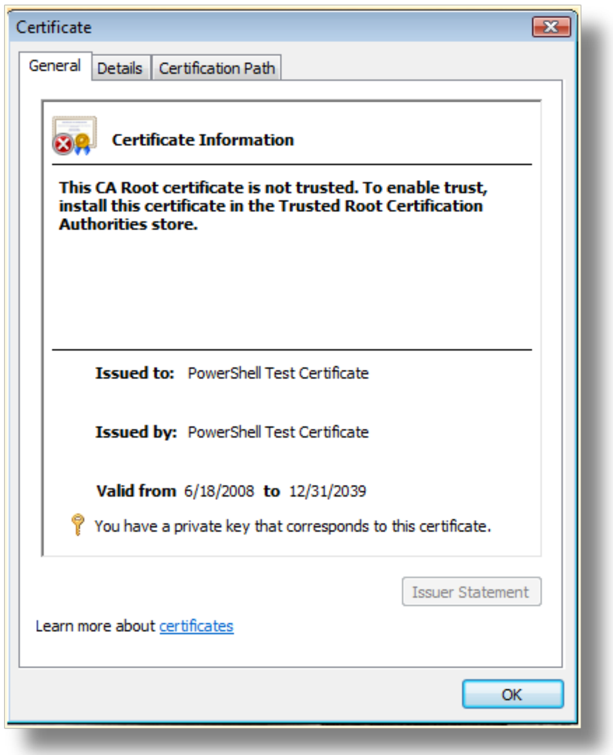
```
$certificate.Verify()

  False
```

And why is the certificate untrustworthy? You can use a little trick to find out the answer. PowerShell can access the options of the *System.Security.dll* library of the .NET framework to get *DisplayCertificate()* to display all the data about the certificate in a clearly understandable dialog box. But first you'll have to use *LoadWithPartialName()* to reload the library:

```
# Show all the certificate data in a dialog box:
[System.Reflection.Assembly]::`
LoadWithPartialName("System.Security")
[System.Security.Cryptography.x509Certificates.X509Certificate2UI]::`
DisplayCertificate($certificate)
```

The dialog box tells you what's wrong with the certificate: "This CA Root certificate is not to be trusted. To enable trust, install this certificate in the Trusted Root Certificates Authorities store." In the area below this, the dialog box reports that *issued by* and *issued for* are identical, meaning that this is a self-signed certificate not issued by any external PKI. To make this certificate trusted, it must be stored additionally in the certificate store of trusted root certification authorities.



Certificate Information

This CA Root certificate is not trusted. To enable trust, install this certificate in the Trusted Root Certification Authorities store.

Issued to: PowerShell Test Certificate

Issued by: PowerShell Test Certificate

Valid from 6/18/2008 to 12/31/2039

You have a private key that corresponds to this certificate.

Figure 10.2: Certificates must be declared trusted

note

In the case of certificates issued by a PKI, there is a difference between the references to *issued by* and *issued for*: after *issued by*, you'll find the name of the signing authority. This is precisely the advantage of PKI: all you need to do is to copy the signing authority just once to the store of trusted root certificate authorities. From then on, all certificates issued by this authority are automatically accepted as trusted. You can use their certificates immediately because the most important commercial certificate authorities are already registered in the store of root certificate authorities and they are valid as a standard of trust.

You can get this done either manually or by letting PowerShell do it for you. The following lines will copy the certificate in *$certificate* to the store of root certificate authorities:

```
$Store = New-Object `
system.security.cryptography.X509Certificates.x509Store( `
"root", "CurrentUser")
$Store.Open("ReadWrite")
$Store.Add($certificate)
$Store.Close()
```

note

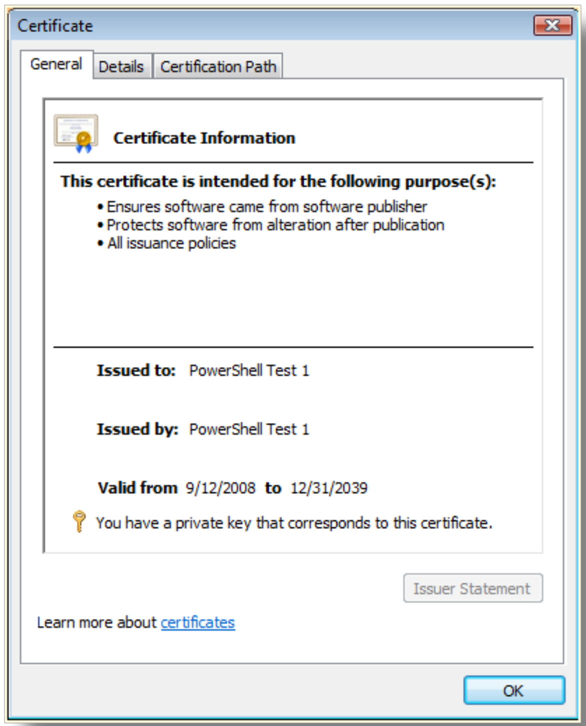
Whenever you put new certificates into the certificate store, a dialog box will ask you whether you really want to do it. This prevents you from running this script unsupervised.

The certificate is immediately trusted; you can use *Verify()* to check it, and the result will now be *True*:

```
$certificate.Verify()

  True
```

If you open the certificate properties again in the dialog box, this will also tell you that the certificate is acceptable. Click the *Certification Path* tab, and you will see the enabled trust. For self-signed certificates, it is the certificate itself. For certificates issued by a PKI, you will see which signing authority certifies that the certificate on your computer is trusted. The uppermost certificate in this view is always in your store of trusted root certificate authorities.



Certificate Information

This certificate is intended for the following purpose(s):
- Ensures software came from software publisher
- Protects software from alteration after publication
- All issuance policies

Issued to: PowerShell Test 1

Issued by: PowerShell Test 1

Valid from 9/12/2008 to 12/31/2039

You have a private key that corresponds to this certificate.

Learn more about certificates

Figure 10.3: The trusted certificate may now be used for signatures

To find out what exactly happened and how to also perform this procedure manually, take a look at your certificate store:

```
certmgr.msc
```

Microsoft Management Console (MMC) opens and shows you your certificate store. In the *Personal Certificates\Certificates* branch, you'll find all your personal certificates, including the code-signing certificates that you created yourself, so you'll also find a copy of your self-signed certificate. If you delete the certificate, it will no longer be trusted. If you use your right mouse button to drag your self-signed certificate from the *Personal Certificates\Certificates* branch to the *Trusted Root Certification Authorities\Certificates* branch, you will only need to select *Copy here* to carry out the same copy procedure that your PowerShell code just automated for you.

Signing PowerShell Scripts

PowerShell script signatures require only two things: a valid code-signing certificate and the script that you want to sign. The cmdlet *Set-AuthenticodeSignature* takes care of the rest.

Using the First Available Certificate

Dir along with the parameter *-codeSigningCert* will retrieve appropriate code-signing certificates. In the most rudimentary case, you can use the first available certificate to sign one—or even all—PowerShell scripts in your current directory. The following lines will create a simple PowerShell script named *test.ps1* and sign this script file with first available code-signing certificate:

```
' "Hello world" ' > test.ps1
$certificate = @(Dir cert:CurrentUser\My `
  -codeSigningCert -recurse)[0]
Set-AuthenticodeSignature test.ps1 $certificate


  directory: C:\Users\Tobias Weltner
  SignerCertificate                         Status   Path
  -----------------                         ------   ----
  E24D967BE9519595D7D1AC527B6449455F949C77  Valid    test.ps1
```

The signature will be directly inserted into the script as a data block and consist of a digital fingerprint of the script (also known as a hash), which can be encrypted using the private key of the certificate. You'll find out how useful this is in the next section.

```
# Disclose the signature in the script file:
type test.ps1

  "Hello world"
  # SIG # Begin signature block
  # MIIEEQYJKoZIhvcNAQcCoIIEAjCCA/4CAQExCzAJBgUrDgMCGgUAMGkGCisGAQQB
  # gjcCAQSgWzBZMDQGCisGAQQBgjcCAR4wJgIDAQABBAfzDtgWUsITrck0sYpfvNR
  # AgEAAgEAAgEAAgEAAgEAMCEwCQYFKw4DAhoFAAQUf02ePVE/w2QMUVYbQhkeTsl4
  # AdqgggIqMIICJjCCAY+gAwIBAgIQ0+Yc503n6LJKxel1bq1xtTANBgkqhkiG9w0B
  # AQQFADAdMRswGQYDVQQDExJQb3dlclNoZWxsVGVzdENlcnQwHhcNMDcwOTE0MTAz
  # MTE0WhcNMzkxMjMxMjM1OTU5WjAdMRswGQYDVQQDExJQb3dlclNoZWxsVGVzdENl
  # cnQwgZ8wDQYJKoZIhvcNAQEBBQADgY0AMIGJAoGBAO99s+DoANjTbcx1AYfvlR0q
  # MnoWKkHm9oc+F8hLAXpI8fPiBnxlqrwhZcmiuE1dE1rYIFktomNNtS0i70G2d445
  # o5mUKRtZ9THuwYGnCY+luDBM5cmN0sjcJK9iPHGgtIjFylYwMXhgHA8bBODc8zf0
  # 54lSoH5NTOB7uZ4fijVfAgMBAAGjZzBlMBMGA1UdJQQMMAoGCCsGAQUFBwMDME4G
  # A1UdAQRHMEWAEAtDyFc0PeNlfKpgXP1kDKahHzAdMRswGQYDVQQDExJQb3dlclNo
  # ZWxsVGVzdENlcnSCENPmHOdN5+iySsXpdW6tcbUwDQYJKoZIhvcNAQEEBQADgYEA
  # lkCaA6rqq9f/RJifhLY3gZPABVtymP6SGbm6LgASLKzYfdhcmsDxOnwQjAzo4xDk
  # nLux4JccT9vFM+0tR/5d3alsY9rH8E+y8gs6opZNsg0ls4CCDrEWCMD3BOk70ch5
  # yVCv0PDqtLboO/O4dcJiGt9HViUNISHMEYnlR1qgBJExggFRMIIBTQIBATAxMB0x
  # GzAZBgNVBAMTElBvd2VyU2hlbGxUZXN0Q2VydAIQ0+Yc503n6LJKxel1bq1xtTAJ
  # BgUrDgMCGgUAoHgwGAYKKwYBBAGCNwIBDDEKMAigAoAAoQKAADAZBgkqhkiG9w0B
  # CQMxDAYKKwYBBAGCNwIBBDAcBgorBgEEAYI3AgELMQ4wDAYKKwYBBAGCNwIBFTAj
  # BgkqhkiG9w0BCQQxFgQUwY+7iwxEhe2RiHMICRnV/mGny5gwDQYJKoZIhvcNAQEB
  # BQAEgYAyscnxSQsTeqIkmh92ros8NBS+L7tvwRDl8KwAwvBVsMTy7cFzz3lnqc5T
  # /25KFjcVp0Id6oKsQgHW07zdlcR7mC9nfwSKPBTE2G1+tmLHNopMqlcwjH0YriBW
  # f25oYXEKRMMgzsuwC4IjblrVGBe+MdcJy1Cmd2qR3UQXm3m6ZA==
  # SIG # End signature block
```

Recursively Signing All PowerShell Scripts

Set-AuthenticodeSignature allows you to sign not only individual scripts, but also many scripts at once in one operation. That means you could use a few lines to sign all your personal PowerShell scripts with your digital signature. *Set-AuthenticodeSignature* will also accept arrays as file names that can contain any number of separate file names. Instead of a fixed file name, enclose in parentheses a subexpression in your statement, and let *Dir* list all the PowerShell scripts in the current directory. They will all be signed immediately.

```
$certificate = @(Dir cert:CurrentUser\My -codeSigningCert -recurse)[0]
Set-AuthenticodeSignature (Dir *.ps1) $certificate

  SignerCertificate                         Status    Path
  -----------------                         ------    ----
  E24D967BE9519595D7D1AC527B6449455F949C77  Valid     filter.ps1
  E24D967BE9519595D7D1AC527B6449455F949C77  Valid     myscript.ps1
  E24D967BE9519595D7D1AC527B6449455F949C77  Valid     net.ps1
  E24D967BE9519595D7D1AC527B6449455F949C77  Valid     calcfunctions.ps1
  E24D967BE9519595D7D1AC527B6449455F949C77  Valid     test.ps1
  E24D967BE9519595D7D1AC527B6449455F949C77  Valid     test1.ps1
  E24D967BE9519595D7D1AC527B6449455F949C77  Valid     test3.ps1
  E24D967BE9519595D7D1AC527B6449455F949C77  Valid     testscript.ps1
  E24D967BE9519595D7D1AC527B6449455F949C77  Valid     unsigned.ps1
```

If you'd like to sign the scripts in your current directory as well as all PowerShell scripts in all subdirectories, the invocation is just as clear because you only need to use the *-recurse* parameter:

```
Set-AuthenticodeSignature (Dir -recurse -include *.ps1) $certificate
```

Selecting Certificates Using the Dialog Box

If there's more than one code-signing certificate on your computer, such as certificates used for diverse purposes, then you surely wouldn't want to use the first available certificate but the most suitable one. One option is to use the certificate name if you know it:

```
$certificate = Dir cert:\CurrentUser\My |
  Where-Object { $_.Subject -eq "CN=PowerShellTestCert" }
```

Another option is to use the built-in dialog box of .NET framework. It lists all certificates for selection that you pass to *SelectFromCollection()*. Before you can do this, you must wrap the certificates in a special collection. In the simplest scenario, you should offer all code-signing certificates for selection:

```
# Text for the dialog box:
$title = "Available identities"
$text = "Please select a certificate for signing"
# Find certificates:
$certificates = Dir cert:\ -recurse -codeSigningCert
# Load System.Security librara and wrap
# certificates in a collection:
[System.Reflection.Assembly]::`
LoadWithPartialName("System.Security")
$collection = New-Object `
System.Security.Cryptography.X509Certificates.X509Certificate2Collection
$certificates | ForEach-Object { $collection.Add($_) }
# Display options:
$certificate = `
[System.Security.Cryptography.x509Certificates.X509Certificate2UI]::`
SelectFromCollection($collection,  $title, $text, 0)
# Use selected certificate to sign
Set-AuthenticodeSignature -Certificate $certificate[0] `
  -FilePath test.ps1


  directory: C:\Users\Tobias Weltner
  SignerCertificate                          Status  Path
  -----------------                          ------  ----
  372883FA3B386F72BCE5F475180CE938CE1B8674   Valid   test.ps1
```

Validating Signed PowerShell Scripts

How exactly do signatures in scripts benefit you and others? The simple answer is they can be validated, both manually and automatically, and tell you whether a PowerShell is trusted or may contain malicious code.

- **Validate it yourself:** For manual validation, check whether a signature is in a PowerShell script and if it is, whether it is unobjectionable. Among other things, you can find out who signed the script, whether the script code was changed, and whether whoever signed the script is someone you trust.
- **Validate automatically:** If you set the PowerShell execution policy to *AllSigned*, PowerShell will carry out validation automatically as soon as you attempt to run the script. The script will run only if the script issuer is trusted and the signature has not been altered since it was signed.

Manual Validation

The cmdlet *Get-AuthenticodeSignature* validates signatures. This cmdlet requires the name of the script file that you want to examine. The script file doesn't have to include a signature. Whether it does or doesn't, the *StatusMessage* property will tell you the script status:

```
' "Hello" ' > unsigned.ps1
$check = Get-AuthenticodeSignature unsigned.ps1
$check.StatusMessage

  The file "C:\Users\Tobias Weltner\unsigned.ps1"
  is not digitally signed. The script will not execute
  on the system. Please see "get-help about_signing"
  for more details.
```

Note that this text conveys exactly the same message that you would receive if you ran an unsigned script, even though the execution policy is set to *RemoteSigned* or *AllSigned*. This means that PowerShell carries out precisely the same validation procedure internally when, depending on the current execution policy, it examines the scripts you try to start. Another equally useful property is *Status*, which summarizes the script status in just one concise phrase:

```
$check.Status

  NotSigned
```

What happens when you inspect script signatures? Table 10.3 provides an overview of possible validation results, as well as causes. You can use *get-authenticodesignature* to easily ascertain the security status of scripts, which scripts have a valid signature, and which scripts lack signatures or whose contents have been modified:

```
Get-AuthenticodeSignature (Dir *.ps1)


  directory: C:\Users\Tobias Weltner
  SignerCertificate                         Status        Path
  -----------------                         ------        ----
  E24D967BE9519595D7D1AC527B6449455F949C77  Valid         filter.ps1
  E24D967BE9519595D7D1AC527B6449455F949C77  Valid         hauptskript.ps1
  E24D967BE9519595D7D1AC527B6449455F949C77  Valid         myscript.ps1
  E24D967BE9519595D7D1AC527B6449455F949C77  Valid         net.ps1
  E24D967BE9519595D7D1AC527B6449455F949C77  Valid         calcfunctions.ps1
  E24D967BE9519595D7D1AC527B6449455F949C77  Valid         test.ps1
  E24D967BE9519595D7D1AC527B6449455F949C77  HashMismatch  test1.ps1
  E24D967BE9519595D7D1AC527B6449455F949C77  UnknownError  test3.ps1
  E24D967BE9519595D7D1AC527B6449455F949C77  Valid         testscript.ps1
  E24D967BE9519595D7D1AC527B6449455F949C77  Valid         unsigned.ps1
                                            NotSigned     unterskript.ps1
```

If you want to see only those scripts that are potentially malicious, whose contents have been tampered with since they were signed (*HashMismatch*), or whose signature comes from an untrusted certificate (*UnknownError*), use *Where-Object* to filter your results:

```
Get-AuthenticodeSignature (Dir *.ps1) |
  Where-Object {(($_.Status -eq "HashMismatch") `
    -or ($_.Status -eq "UnknownError"))}


   directory: C:\Users\Tobias Weltner
   SignerCertificate                          Status         Path
   -----------------                          ------         ----
   E24D967BE9519595D7D1AC527B6449455F949C77   HashMismatch   test1.ps1
   94FD1387CE1CA1340E59A7B16541C6179FDEEC7D   UnknownError   test3.ps1
```

Status	**Message**	**Description**
NotSigned	The file "xyz" is not digitally signed. The script will not execute on the system. Please see "get-help about_signing" for more details.	Since the file has no digital signature, you must use Set-AuthenticodeSignature to sign the file.
UnknownError	The file "xyz" cannot be loaded. A certificate chain processed, but ended in a root certificate which is not trusted by the trust provider.	The used certificate is unknown. Add the certificate publisher to the trusted root certificates authorities store.
HashMismatch	File XXX check this cannot be loaded. The contents of file "â€¦" may have been tampered because the hash of the file does not match the hash stored in the digital signature. The script will not execute on the system. Please see "get-help about_signing" for more details.	The file contents were changed. If you changed the contents yourself, resign the file.
Valid	Signature was validated.	The file contents match the signature and the signature is valid.

Table 10.3: Status reports of signature validation and their causes

Automatic Validation

You don't need to validate the signatures of your script files because PowerShell will carry out validation automatically when you try to start a script. The script will run only if the script file signature is valid. In all other cases, you will get an error message like those in Table 10.3. In this way, you can ensure that only those scripts will run that were inspected by a trusted authority and were found to be valid (that is, signed). Automatic validation will alert you as well if the script contents have been subsequently modified.

Automatic validation is always active when you use *Set-ExecutionPolicy* to set the execution policy either to *AllSigned* or *RemoteSigned*. All scripts will be tested in principle if you choose *AllSigned*.

note If you set your execution policy to *AllSigned*, you should make sure that your profile scripts are correctly signed. Otherwise, PowerShell will no longer execute the profile scripts.

If you select *RemoteSigned*, only those scripts will be checked that you downloaded from the Internet, received as an e-mail attachment, or from some other unreliable source. Here's a little test:

```
# Set ExecutionPolicy to AllSigned. All
# scripts must now have a valid signature:
Set-ExecutionPolicy AllSigned
# Create an unsigned test script file.
# It will not be able to run:
' "Hello world" ' > test1.ps1
.\test1.ps1

  The file "C:\Users\Tobias Weltner\test1.ps1"
  cannot be loaded. The file "C:\Users\Tobias
  Weltner\test1.ps1" is not digitally signed.
  The script will not execute on the system. Please see
  "get-help about_signing" for more details.
  At line:1 char:11
  + .\test1.ps1 <<<<

# Sign the script file with an untrusted certificate:
$certificate = Dir cert:\CurrentUser\My |
  Where-Object { $_.Subject -eq "CN=malicious certificate" }
Set-AuthenticodeSignature test1.ps1 $certificate

  directory: C:\Users\Tobias Weltner
  SignerCertificate                         Status   Path
  -----------------                         ------   ----
  94FD1387CE1CA1340E59A7B16541C6179FDEEC7D  Valid    test1.ps1

# If the certificate is not trusted,
# you will always get an error message:
```

```
.\test1.ps1

  The file "C:\Users\Tobias Weltner\test1.ps1"
  cannot be loaded. A certificate chain processed,
  but ended in a root certificate which is not
  trusted by the trust provider.
  At line:1 char:11
  + .\test1.ps1 <<<<

# Sign the script with a trusted certificate:
$certificate = Dir cert:\CurrentUser\My |
  Where-Object { $_.Subject -eq "CN=PowerShellTestCert" }
Set-AuthenticodeSignature test1.ps1 $certificate


  directory: C:\Users\Tobias Weltner
  SignerCertificate                         Status   Path
  -----------------                         ------   ----
  E24D967BE9519595D7D1AC527B6449455F949C77  Valid    test1.ps1

# If you used a trusted certificate for the signature,
# the script will be allowed to run:
.\test1.ps1

  Hello world
```

note

The sole difference between a trusted and an untrusted certificate is the question of whether the certificate publisher is specified in the special *trusted root certificates authorities* store. But even when you invoke a script signed with a trusted certificate, your first invocation will be accompanied by an additional query:

```
Do you want to run software from this untrusted publisher?
The file "C:\Users\Tobias Weltner\testscript.ps1" is
published
by "CN=PowerShellTestCert". This publisher is not trusted on
your system. Only run scripts from trusted publishers.
[E] Never run  [N] Do not run  [M] Run once  [A] Always run
[?] Help (default is "N"):
```

Only when you answer by selecting "A" for "Always run" will the certificate publisher be placed in the trusted root certificates authorities store. Then, you won't be pestered with further queries for all the scripts signed with this certificate. If you'd like to avoid this query from the start, simply add the publisher of your script to the list of trusted root certificates authorities and also to the list of trusted publishers. With self-signed certificates, you could type:

```
# Select certificate:
$name = "PowerShellTestCert"
```

```
$certificate = Dir cert:\CurrentUser\My |
  Where-Object { $_.Subject -eq "CN=$name " }
# Declare certificate publisher to be generally trusted
$Store = New-Object `
  system.security.cryptography.X509Certificates.x509Store( `
  "root", "CurrentUser")
$Store.Open("ReadWrite")
$Store.Add($certificate)
$Store.Close()
# Run certificates of this publisher:
$Store = New-Object `
  system.security.cryptography.X509Certificates.x509Store( `
  "TrustedPublisher", "CurrentUser")
$Store.Open("ReadWrite")
$Store.Add($certificate)
$Store.Close()
```

Building a Miniature PKI

You've seen that you can use self-signed certificates to fully utilize PowerShell security functions without an elaborate PKI. While a managed PKI is the better approach, you should also look at how you can build your own miniature PKI with the help of the Microsoft tool *makecert.exe.* before you decide to entirely forego the security of digital signatures just because you have no PKI available.

In the following example, the intended aim is to allow a business department to sign PowerShell scripts created by you with valid signatures. The signatures are to be valid across the enterprise. In addition, every staff member of the department will receive a personal certificate so that it will be possible to trace who has signed which script.

Creating a Root Certificate

The first step is to create for the department a root certificate, which will not actually be used later for signing purposes. It serves merely as publisher of staff certificates. The root certificate will not be created in the certificate store of the current user but in the *Local Machine* store so you will require administrator privileges. This is how to create a root certificate:

```
$departmentname = "IT Department 23"
pushd
Cd "$env:programfiles\Microsoft Visual Studio 8\SDK\v2.0\Bin"
.\makecert -n "CN=$departmentname" -a sha1 -eku 1.3.6.1.5.5.7.3.3 `
  -r -sv root.pvk root.cer -ss Root -sr localMachine

  Succeeded

Popd
```

Makecert has created the root certificate as well as the files *root.pvk* and *root.cer*. Both will be used later but right now you should verify that the certificate was created properly:

```
$certificate = Dir cert:\LocalMachine\Root |
  Where-Object { $_.Subject -eq "CN=$departmentname" }
$certificate


   directory: Microsoft.PowerShell.Security\Certificate::
   LocalMachine\Root
   Thumbprint                                Subject
   ----------                                -------
   AD68EC74428B4F294B1FDF7EB8A64D5ED327F84B  CN=IT Department 23
```

Creating Staff Certificates

With the help of the root certificate, you can now create any number of staff certificates as long as you know the secret password that you stipulated when creating the root certificate. Ideally, only the department head knows the password. This is how you would proceed to create a new staff certificate:

```
$staff = "Tobias Weltner"
pushd
Cd "$env:programfiles\Microsoft Visual Studio 8\SDK\v2.0\Bin"
.\makecert -pe -n "CN=$staff" -ss MY -a sha1 -eku 1.3.6.1.5.5.7.3.3 `
  -iv root.pvk -ic root.cer

   Succeeded

popd
```

important

Makecert registers the previous root certificate as publisher in the new staff certificate. This information is loaded by *makecert* from the *root.pvk* and *root.cer* files, which were generated when the root certificate was created. You should store these two files in a safe location as soon as all staff certificates have been created. You will need these two files if you want to create additional staff certificates later. Protect in particular the *root.pvk* file from unauthorized access, because whoever has this file (as well as the secret access code you invented when you created the root certificates) can make new staff certificates.

Verify that the staff certificate was created properly:

```
$staff = "Tobias Weltner"
$certificate = Dir cert:\CurrentUser\My |
  Where-Object { $_.Subject -eq "CN=$staff" }
[System.Reflection.Assembly]::`
```

```
  LoadWithPartialName("System.Security")
  [System.Security.Cryptography.x509Certificates.X509Certificate2UI]::`
  DisplayCertificate($certificate)
```

The dialog box will now show differing specifications for *Issued by* and *Issued for*. The issuer of the staff certificate is now your new root certificate, and if you click the *Certification path* tab, you'll then see a genuine chain of trust starting with the root certificate for your department. That has great advantages because now all that remains to be done is to register your root certificate in the store of trusted root certification authorities in the entire enterprise. All the staff certificates originating from your root certificate are now automatically trusted.

Creating a Backup

Every staff member should save a copy of his staff certificate and store it in a protected location. The backup can be done directly from within PowerShell. The following lines will create a password-protected PFX file with the name *backup.pfx* in the current directory. In the example, the password is set to "strictlyconfidential" and, of course, should never be modified. The certificate, along with its secret and private key can be imported again only if the specified password is known.

```
$filename = "$(get-location)\backup.pfx"
$pwd = "strictlyconfidential"
[System.Reflection.Assembly]::LoadWithPartialName("System.Security")
$collection = New-Object `
System.Security.Cryptography.X509Certificates.X509Certificate2Collection
$collection.Add($certificate)
$bytes = $collection.Export(3, $pwd)
$filestream = New-Object System.IO.FileStream($filename, "Create")
$filestream.Write($bytes, 0, $bytes.Length)
$filestream.Close()
```

If you assume the role of department head, you can now create a code-signing certificate for every staff member, generate a respective *pfx* backup copy, and then forward this to every staff member. To open this *pfx* file, a staff member would only need to double-click the file, enter the assigned password, and confirm all further settings. Finally, the certificate could be installed in its own certificate store, and staff members could begin to sign their scripts.

Installing Enterprise-Wide Root Certificates

Your "miniature PKI" should already be functioning on the computer where you stored the root certificate. So that your new staff certificates are recognized enterprise-wide, register the root certificate across the enterprise in the store of trusted root certification authorities. You can do that either manually or you can use Group Policy guidelines in an Active Directory for automatic distribution.

PowerShell installs the root certificate in the *root.cer* file in the system-wide store of trusted root certification authorities in the following way:

```
copy "$env:programfiles\Microsoft Visual Studio 8\SDK\v2.0\Bin\root.cer" `
  "root.cer"
$Store = New-Object `
```

```
    system.security.cryptography.X509Certificates.x509Store( `
    "root", "LocalMachine")
  $filename = "$(get-location)\root.cer"
  $store.Open("ReadWrite")
  $collection = New-Object `
    System.Security.Cryptography.X509Certificates.X509Certificate2Collection
  $collection.Import($filename)
  $store.Add($collection[0])
  $store.Close()
```

You could likewise open the *root.cer* file by double-clicking it or invoke it from within PowerShell:

```
  .\root.cer
```

In this case, you would install the certificate interactively with the help of an assistant. In the dialog box, click the *Install certificate* button. Follow the directions of the assistant, and select the option *Save all certificates in the following store*. Click *Search*.

A further dialog box should open. Select the option *Display physical store*. Then select in the upper tree structure the following branch: *Trusted root certification authorities/Local computer*. Click *OK* and then *Continue* to install the certificate.

Summary

PowerShell scripts are text files with a ".psl" file extension. They function like the batch files of older consoles and may include any PowerShell statements. If you start a PowerShell script, PowerShell will execute its included statements.

You can't start scripts without the permission of the execution policy. This setting initially prohibits scripts from starting, but an administrator can use *Set-ExecutionPolicy* to change the setting (see Table 10.1) and specify which scripts are allowed to start. The execution policy can specify that only those scripts may run that have a valid digital signature; it can also distinguish between local scripts and scripts originating from the Internet.

To execute a PowerShell script, the script must be invoked with its relative or absolute path name. For this reason, it does not suffice to specify only the script name unless the script is in a trusted directory, meaning all directories that are named in the *Path* environment variable. Another way to launch scripts comfortably is to use an alias name that you assign to the script with the help of *Set-Alias*.

Arguments can be passed to scripts. PowerShell automatically analyzes all the data that you specify after a script name when you invoke a script, and it uses a space as separator for arguments. The arguments are provided to the script in *$args*. Alternatively, the script can also bind arguments to set parameters. To do so, the parameters, much like functions, are defined inside the script by using the *Param* statement.

So to ensure that elaborate scripts remain clearly understandable, individual tasks should be encapsulated as functions. Functions must always be located at the beginning of a script. However, they can be relocated to an external library script that is subsequently reloaded by a work script similar to an *Include* statement.

PowerShell scripts may be used inside the pipeline. So that scripts do not block the pipeline, they must, like functions, define at least one *process* block. The block is separately invoked for every object in the pipeline.

All variables and functions that a script creates are private and apply only within the script. If you want to cancel their isolation, carry out a dot-sourced invocation of scripts and functions, such as typing a single dot in front of them when they are called. Set the validity of separate variable and function layers by using area designators like *script:* and *global:*.

When starting, PowerShell automatically looks for a series of profile scripts. If they are present, PowerShell runs them automatically provided that the execution policy allows their execution. You can set up the PowerShell work environment in the profile scripts and define alias names or functions that are to be provided automatically after PowerShell starts.

Digital signatures ensure that a script originates from a trusted source and has not been subsequently modified. You can imagine such scripts as a stamp of quality. Depending on the execution policy setting, PowerShell will permit only those scripts to run that have this stamp of quality.

CHAPTER 11.

Finding and Avoiding Errors

The more complex your commands, pipelines, functions, or scripts become, the more often that errors can creep in. PowerShell has its own remedies for finding and correcting errors at various levels of complexity.

In simple cases, use "what-if" scenarios to check whether a command or a pipeline is really doing what you expect it to do. With the help of such scenarios, you can simulate the result of commands without actually executing the commands. You can permit commands to do their work only after you're convinced that the commands will function flawlessly.

If you've written your own functions or scripts, PowerShell can also step through the code and halt its execution at locations called breakpoints, which allow you to examine functions or scripts more closely at these locations. You can verify whether variables actually do contain an expected result. Moreover, PowerShell offers you the option of integrating debugging messages into functions or scripts. This enables your code to output progress reports to you at key locations when your code is in the development stage.

Topics Covered:

- Summary

"What-if" Scenarios

Automation is enormously convenient, but it you can also automate errors into the process that can wreak total havoc. That's why PowerShell has some mechanisms t to check and protect against potentially dangerous processes: these mechanisms are simulation and stepped confirmation.

Dry Runs: Simulating Operations

If you'd like to first find out what effects a particular command *could* have when you use it, try simulation. PowerShell will make no changes to your system but show you what would happen if you were to run a command without simulation. Use the *-whatif* parameter, which many cmdlets support, to turn on simulation.

```
# What exactly would happen if Stop-Process
# ended all processes beginning with "c"?
Stop-Process -Name c* -WhatIf

  WhatIf: "Stop-Process" operation is run for the target "ccApp (920)".
  WhatIf: "Stop-Process" operation is run for the target "CCC (5612)".
  WhatIf: "Stop-Process" operation is run for the target "ccSvcHst (1848)".
  WhatIf: "Stop-Process" operation is run for the target "conime (5280)".
  WhatIf: "Stop-Process" operation is run for the target "csrss (632)".
  WhatIf: "Stop-Process" operation is run for the target "csrss (688)".
```

Of course, your own functions and scripts will support simulation only if you integrate them. Do this by simply defining a switch parameter called *whatif*:

```
function MapDrive([string]$driveletter, `
  [string]$target, [switch]$whatif)
{
  If ($whatif)
  {
    Write-Host "WhatIf: creation of a network drive " + `
    "with the letter ${driveletter}: at destination $target"
  }
  Else
  {
    New-PSDrive $driveletter FileSystem $target
  }
}
# Simulate the command first to see what it does:
MapDrive k \\127.0.0.1\c$ -whatif

  WhatIf: creation of a network drive
  with letter k: at destination \\127.0.0.1\c$

# Execute command:
```

```
MapDrive k \\127.0.0.1\c$

  Name        Provider      Root
  ----        --------      ----
  k           FileSystem    \\127.0.0.1\c$
```

Stepped Confirmation: Separate Queries

As you've seen, PowerShell commands, mainly by using wildcards like "*", are capable of carrying out several tasks at once. To prevent unintentional operations from running, you can give the command the task of asking for confirmation before carrying out every single operation. In contrast to simulation, stepped confirmation gives you the option of actually carrying out operations one at a time, or all at once. Use the *-Confirm* parameter to turn on stepping:

```
Stop-Service a* -Confirm

  Confirm
  Are you sure you want to perform this action?
  Performing operation "Stop-Service" on Target "ApplicationLookup (AeLookupSvc)".
  |Y| Yes  |A| Yes to All   |N| No  |L| No to All  |S| Suspend  |?| Help :
  Confirm
  Are you sure you want to perform this action?
  Performing operation "Stop-Service" on Target "Agere Modem Call Progress Audio
  (AgereModemAudio)".
  |Y| Yes  |A| Yes to All   |N| No  |L| No to All  |S| Suspend  |?| Help:
```

The confirming procedure offers you six options for each action that can be selected by pressing a button.

Option	**Description**
Yes	Action will be carried out
Yes to all	Action will be carried out and all remaining actions will also be carried out without further queries
No	Action will not be carried out
No to all	Action will not be carried out and the remaining actions will also not be carried out without further queries (terminate)
Suspend	The action will be interrupted and you will be returned to the prompt, where you can carry out additional checks. As soon as you type the command "exit", you will continue the interrupted action

Help	Supplies Help information

Table 11.1: Selection options in stepped confirmation

Automatic Confirmation of Dangerous Actions

Because some operations are more critical than others, developers of PowerShell cmdlets have assigned a risk evaluation to each command. There are three settings to choose from: *Low*, *Medium,* and *High*.

The *Stop-Process* cmdlet, which is used to stop running processes and programs, is set to *Medium* because while it is somewhat risky to stop processes, you normally shouldn't expect any irreversible damage. The Exchange cmdlet, used to remove a user mailbox, is categorized as *High* because when a mailbox is deleted all of its contents are lost as well.

You may not change this risk assessment, but you can respond to it. PowerShell's default setting requires that it check with you automatically about operations in the *High* risk category even if you haven't specified the *-Confirm* parameter. This standard setting is stored in the *$ConfirmPreference* variable so you can respond by making the default less or more rigorous. If you set *$ConfirmPreference* to "*Low*"(and use quotation marks), PowerShell will automatically question all actions. But if you set *$ConfirmPreference* to *"None"*, PowerShell will no longer automatically question any actions, even if cmdlets are set to *High*.

```
# Calculator may be started and stopped without being called
# into question because Stop-Process is in the Medium category:
Calc
Stop-Process -Name calc
# If the default setting is changed from High to Low,
# PowerShell will automatically question every action:
$ConfirmPreference = "Low"
calc
Stop-Process -Name calc

  Confirm
  Are you sure you want to perform this action?
  "Stop-Process" operation is run for the target "calc(2388)".
  |Y| Yes  |A| Yes to All   |N| No  |L| No to All  |S| Suspend  |?| Help:
```

Two consequences result from this:

- **High-risk environment:** If you are uncertain, or working in an environment in which the slightest error can have far-reaching consequences, set *$ConfirmPreference* to *"Low"* so that you will be queried even for actions that aren't so hazardous.
- **Unintentional execution:**If actions run unintentionally, then no interactive queries should appear, not even for risky actions. In such cases, turn off querying by using the *-Confirm: $false* parameter for a single command. Alternatively, turn off automatic querying in general

by setting *$ConfirmPreference="None"*. If you'd like to turn off automatic querying for scripts only but still keep the console in interactive mode, then set *$script:ConfirmPreference="None"* inside your script.

Defining Fault tolerance

PowerShell is very tolerant when errors occur: it simply continues execution—and that is often exactly the mode you want. For example, imagine if you started a file copying action that takes several hours. Returning to your system some time later, you wouldn't be pleased to find out that the operation had already been halted after the fifth data file because of an error. PowerShell default settings take this into account and carry out your tasks to the greatest possible extent rather than stopping them because of errors.

If an error fails to cause PowerShell to halt an entire task, you can end up with undesired consequences. Although PowerShell can't locate the file in the previous example and can't delete it for this reason, the subsequent command is executed anyway, and PowerShell concludes its work with a cheerful "Done!".

```
Del "nosuchthing"; Write-Host "Done!"

  Remove-Item : Cannot find "C:\Users\Tobias Weltner\nosuchthing"
  because it does not exist.
  At line:1 char:4
  + Del  <<<< "nosuchthing"; Write-Host "Done!"
  Done!
```

pro tip

If you set the *$ErrorView* automatic variable to the *CategoryView* value, PowerShell will sum up error messages briefly in just one line, and that's the better policy for real professionals:

```
$errorview

  NormalView

1/$null

  Attempted to divide by zero.
  At line:1 char:3
  + 1/$ <<<< null

$errorview = "categoryview"
1/$null

  NotSpecified: (:) [], RuntimeException
```

To determine how PowerShell handles errors, use *ErrorAction*, which specifies whether an error may terminate or may not terminate an operation. The default setting is *"Continue"*, meaning that PowerShell will report an error but continue. Set *ErrorAction* to *"Stop"* so that PowerShell doesn't just go on processing the next statement but stops if a terminating error crops up. This setting will be in effect for all subsequent commands or only for a particular one as the case may be.

If the setting is supposed to apply to one particular command, use the *-ErrorAction* parameter of the command to set *ErrorAction*. Then the next command will halt the action and will no longer output any messages that the action was successful:

```
Del "nosuchthing" -ErrorAction "Stop"; Write-Host "Done!"

  Remove-Item : Command execution stopped because the shell variable
  "ErrorActionPreference" is set to Stop: Cannot find path
  "C:\Users\Tobias Weltner\nosuchthing" because it does not exist.
  At line:1 char:4
  + Del  <<<< "nosuchthing" -ErrorAction "Stop"; Write-Host "Done!"
```

On the other hand, if you want the setting to apply universally as a new default to all commands, then assign it to the *$ErrorActionPreference* variable. Take the example of a script: type this statement at the beginning of your script if you prefer actions in general to be stopped when errors occur:

```
$script:ErrorActionPreference = "Stop"
```

note

Whenever you let a cmdlet run, PowerShell checks first to see whether you used the *-ErrorAction* parameter to set the *ErrorAction* for the cmdlet. If not, PowerShell will use as an alternative the value deposited in *$ErrorActionPreference*. If you would like to change the default in scripts only and not in the interactive console, then use a local variable in the script the way you did in the above example. Local variables begin with the "*script:*" prefix.

Setting	**Description**
SilentlyContinue	Suppress error message; continue to run the next command
Continue	Output error message; continue to run next command (default)
Stop	Halt the execution
Inquire	Query

Table 11.2: Setting options for ErrorAction and $ErrorActionPreference

Recognizing and Responding to Errors

If you want to react to errors yourself so you can output your own, more readable error messages, you'll need two things: first, a way to suppress the built-in error message; second, a mechanism telling you whether an error has arisen or not. You already know how to suppress error messages because you have, once again, dealt with by *ErrorAction*. If you set it to *"SilentlyContinue"*, then PowerShell will no longer output any error messages. You've already taken the first step:

```
Del "nosuchthing" -ErrorAction "SilentlyContinue"
```

Error Status in $?

Evaluate the *$?* variable as well to give the user feedback about whether an action was successful or not. . It will tell you whether an error has occurred. If one has, the variable will contain the value *$false*. This should give you enough to write a little evaluation script:

```
Del "nosuchthing" -ErrorAction "SilentlyContinue"
If (!$?) { "Didn't work!"; break }; "Everything's okay!"
```

If you're now wondering about the peculiarity of the conglomeration "(!$?)", here's a brief refresher: "!" stands for the logical "Not" operator. The condition is met if the *$?* variable doesn't contain the *$true* value (meaning that an error has occurred). *Break* ensures that the string doesn't keep on running. The result is that the text "Everything's okay!" will be output only if an error hasn't occurred.

If you'd like to find out just what sort of error came up, inspect the element *0* in the *$error* array. PowerShell keeps a record of all errors in *$error*. The most recent one is in the element *0*:

```
Del "nosuchthing" -ErrorAction "SilentlyContinue"
If (!$?) { "Error: $($error[0])"; break }; "Everything's okay!"

  Error: Cannot find path "u:\nosuchthing" because it does not exist.
```

Using Traps

Alternatively, you can use so-called "traps". If you know that a particular command may not execute successfully under runtime conditions, then note in front of it what should happen if an error occurs:

```
Trap { "A dreadful error has occurred!"} 1/$null

  A dreadful error has occurred!
  Attempted to divide by zero.
  At line:1 char:53
  + Trap { "A dreadful error has occurred!"} 1/$ <<<< null
```

This shows that the *Trap* statement specifies PowerShell code that is meant to run as soon as an error occurs that cannot be handled in any other way.

Traps Require Unhandled Exceptions

To get this to work, an error really does have to occur or, to be precise, an unhandled exception has to come up. In the next example, you'll see that this is not always the case because the code after *Trap* is not executed, even though an error message pops up:

```
Trap { "A dreadful error has occurred!"} 1/0

  Attempted to divide by zero.
  At line:1 char:53
  + Trap { "A dreadful error has occurred!"} 1/0 <<<<
```

The reason: the *1/0* statement consists exclusively of constant values; that's why PowerShell evaluates it even as it is being compiled. The parser that performs this task recognizes entirely on its own that the statement is an invalid numerical value and handles the error itself. So, it isn't even reported to *Trap*. Very much the same thing happens with most cmdlets because when a cmdlet triggers an error, the error is likewise processed internally by the cmdlet and is not reported to *Trap*:

```
Trap { "A dreadful error has occurred!" } Del "nosuchthing"

  Remove-Item : Cannot find path "C:\Users\Tobias Weltner\nosuchthing"
  because it does not exist.
  At line:1 char:54
  + Trap { "A dreadful error has occurred!"} Del  <<<< "nosuchthing"
```

Surely, it must be possible to catch an error inside a cmdlet? Yes, but only if you set the *ErrorAction* of the cmdlet to *"Stop"*, which ensures that the error does in fact get reported back to the caller and that the cmdlet doesn't snare it internally:

```
Trap { "A dreadful error has occurred!" } `
  Del "nosuchthing" -ErrorAction "Stop"

  A dreadful error has occurred!
  Remove-Item : Command execution stopped because the
  shell variable "ErrorActionPreference" is set to Stop:
  Cannot find path "C:\Users\Tobias Weltner\nosuchthing"
  because it does not exist.
  At line:1 char:54
  + Trap { "A dreadful error has occurred!"} Del  <<<< "nosuchthing"
```

Using Break and Continue to Determine What Happens after an Error

After *Trap* has processed the error by executing the code you specified after *Trap*, it continues execution. That means that PowerShell will output the error message about the current error and continue execution with the next command just as if nothing at all had happened. That's why in the next example your own error message is output first, then PowerShell's, and finally all further commands, which in this case means the text "*Hello*":

```
Trap { "A dreadful error has occurred!" } `
  Del "nosuchthing" -ErrorAction "Stop"; "Hello"

   A dreadful error has occurred!
   Remove-Item : Command execution stopped because the shell variable
   "ErrorActionPreference" is set to Stop: Cannot find path
   "C:\Users\Tobias Weltner\nosuchthing" because it does not exist.
   At line:1 char:54
   + Trap { "A dreadful error has occurred!"} Del  <<<< "nosuchthing"

Hello
```

If you would like a different response, use the keyword *Break* or *Continue* in the *Trap* statement. If you specify *Continue*, *Trap* will behave to a certain extent like the *ErrorAction "SilentlyContinue"* and will suppress the integrated PowerShell error message:

```
Trap {"A dreadful error has occurred!";Continue} `
  Del "nosuchthing" -ea "Stop"; "Hello"

   A dreadful error has occurred!
   Hello
```

Trap continues execution with the next statement, which is in the same block as *Trap* itself. That might seem to be hedged in with too many clauses, but that doesn't play any role in this example because there's only one area. A little later on, you'll see that such a subtlety is actually very crucial.

If you use the *Break* statement instead of *Continue*, *Trap* will respond to a certain extent like the *ErrorAction "Stop"* and will generate its built-in error message. Subsequent statements will no longer be executed.

Finding Out Error Details

Inside the code after *Trap*, PowerShell automatically inserts the *$_* variable, which includes all details about the current error. Your "universal" Trap might look like this if you want to catch an error and output details:

```
Trap { Write-Host -Fore Red -back White $_.Exception.Message; `
  Continue }; 1/$null
```

Error Records: Error Details

You have just output details about the error using the *$error* automatic variable and *$_* inside the *Trap* block. Let's take a closer look at what is actually stored in these variables and how an *Error Record* looks. *Error Records* are precisely what the name says, namely what you normally see when an error occurs in PowerShell: the actual error message, which PowerShell displays in red:

```
Dir MacGuffin

  Get-ChildItem : Cannot find path "C:\Users\Tobias Weltner\MacGuffin"
  because it does not exist.
  At line:1 char:4
  + Dir  <<<< MacGuffin
```

tip

You may have already asked yourself where does PowerShell actually set the color of its error message? This setting is located in *$host.PrivateData*. The following lines will set error message colors to red on a white background:

```
$host.PrivateData.ErrorForegroundColor = "Red"
$host.PrivateData.ErrorBackgroundColor = "White"
```

You can also find additional properties in the same location which enable you to change the colors of warning and debugging messages.

However, this is only how *Error Records* look when you output the records in the console because PowerShell, as always, reduces the object with its wealth of information to text. Just how do you access the actual *Error Record* object? There are four approaches:

- **Redirection:** Redirect the error stream to a variable.
- **The -ErrorVariable parameter:** The error record will be stored in this variable if you use the *-ErrorVariable* parameter to specify a variable name.

pro tip

If you put a plus sign in front of the variable name, the error will be added to the variable so that you could store several errors in the variable: *-ErrorVariable +listing*

- **$error:** All errors will be stored as an error record in the *$error* variable. As a result, the last error is in *$error[0]*.
- **Traps and $_:**Inside the *Trap* statement, the current error record is provided in *$_*.

Error Record by Redirection

If you want to redirect a command result, use the redirection operator ">":

```
Dir MacGuffin > error.txt
Get-Content error.txt
```

Unfortunately, that won't help if the command outputs an error, because errors are not written in the standard stream but in the *Error* stream. If you want to redirect it, the redirection operator must be "2>":

```
Dir MacGuffin 2> error.txt
Get-Content error.txt

  Get-ChildItem : Cannot find path "C:\Users\Tobias Weltner\MacGuffin"
  because it does not exist.
  At line:1 char:4
  + Dir  <<<< MacGuffin 2> error.txt
```

It works: the error message—the *Error Record*—was in fact redirected and written in a file that *Get-Content* subsequently reads. However, *Error Record* is actually not text at all but, like nearly everything else in PowerShell, an object containing much more information than its plain text representation. When you redirect *Error Record* to a file, much of the data contained in *Error Record* gets lost in the process. The clever method is this:

```
# Redirect Error Record and move it into the pipeline and
# assign it to $myerror afterwards
$myerror = Del "nosuchthing" 2>&1
# $myerror now contains the Error Record in object form
# so that error details can be queried:
# Error message:
$myerror.Exception.Message

  Cannot find path "C:\Users\Tobias Weltner\nosuchthing"
  because it does not exist.

# Error cause:
$myerror.InvocationInfo

  MyCommand          : Remove-Item
  ScriptLineNumber : 1
  OffsetInLine       : -2147483648
  ScriptName         :
  Line               : $myerror = Del "nosuchthing" 2>&1
  PositionMessage    :
                       At line:1 char:15
                       + $myerror = Del  <<<< "nosuchthing" 2>&1
  InvocationName     : Del
  PipelineLength     : 1
  PipelinePosition : 1
```

```
# Clearly erroneous identification:
$myerror.FullyQualifiedErrorId

  PathNotFound,Microsoft.PowerShell.Commands.RemoveItemCommand
```

The central point of this example is the redirection to *&1*, a character combination that stands for the output pipeline. Think about this for a moment: If you had passed a valid directory name to the *Dir* command, the command would have retrieved the directory listing, and you could have stored the result in a variable without any difficulty. Nobody would have wondered:

```
$result = Dir
```

By using the "*2>&1*" redirection operator, you can simply send just the error information— *Error Record*—over the same route, and that's why you can directly allocate *Error Record* to a variable and evaluate it afterwards. The properties of *Error Record* listed in Table 11.3 are available to you.

Property	**Description**
CategoryInfo	The error is assigned to broad category, activity, cause, caller, and call type. In this way, similar errors of differing origin can be recognized and jointly handled.
ErrorDetails	Often this is null; developers can deposit additional information here about the error.
Exception	The underlying .NET exception matching the error. *Exception.Message* provides you the error message.
FullyQualifiedErrorID	Specific and special misidentification allowing you to identify the error and enable appropriate follow-up action.
InvocationInfo	Supplies information about where the error occurred, such as the script name and its location in the script.
TargetObject	The object that was operated on when the error occurred. Often null or text corresponding to the argument that a cmdlet could not process.

Table 11.3: Properties of an error record

But note that you are given these properties only if the error record was actually output visibly without redirection. The following statement returns "null":

```
$myerror = Del "nosuchthing" -ea "SilentlyContinue" 2>& amp;1
```

Error Record(s) Through the -ErrorVariable Parameter

Redirection isn't always necessary. Most cmdlets support the *-ErrorVariable* parameter after you specify the name of a variable. The *Error Record* will then be stored in this variable independently of the current *ErrorAction*:

```
Del "nosuchthing" -ErrorVariable myError -ErrorAction "SilentlyContinue"
```

However, what is now present in *$myError* isn't quite identical to what redirection stored in *$myError*. In the redirection process, exactly one *Error Record* was stored—namely the one that would have otherwise been visibly displayed as an error message. The *-ErrorVariable* parameter always returns an array. The array has only one element, but if you want to evaluate the *Error Record* and its manifold properties, you will have to specifically access this array element:

```
$myError[0].Exception.Message
Cannot find path "C:\Users\Tobias Weltner\nosuchthing" because it does not exist.
```

And why is *Error Record* stored in an array? Isn't that totally superfluous when, after all, there's only one *Error Record*? Several *Error Records* can in fact exist. In the next example, the directory listings will be retrieved from three different directories where none exists. The result is three *Error Records*:

```
Dir nosuchthing,notthere,whereisit `
  -ErrorVariable myError -ErrorAction "SilentlyContinue"
$myError.Count
3
```

You can also collect the *Error Records* of several statements in your variable to document entire sequences of errors. Just type a "+" in front of the variable name for the *-ErrorVariable* parameter.

```
Cd notthere -ErrorVariable listing -ErrorAction "SilentlyContinue"
Del nosuchthing -ErrorVariable + listing -ErrorAction "SilentlyContinue"
$listing

  Set-Location : Cannot find path "C:\Users\Tobias Weltner\notthere"
  because it does not exist.
  At line:1 char:3
  + Cd  <<<< notthere -ErrorVariable listing -ErrorAction "SilentlyContinue"
  Remove-Item : Cannot find path "C:\Users\Tobias Weltner\nosuchthing"
  because it does not exist.
  At line:1 char:4
  + Del  <<<< nosuchthing -ErrorVariable +listing -ErrorAction "SilentlyContinue"
```

tip

In case you're asking yourself why PowerShell outputs all *Error Records* at the same time when you're outputting *$listing* in the example, remember that PowerShell converts the contents of an array into text automatically if you fail to explicitly select a specific element from it.

Error Records Through $Error

There's still another way to get to *Error Records*. PowerShell keeps exacting records of all errors and stores these records in the *$Error* variable. So, even if you've forgotten to redirect the *Error Record* in time or to specify the *-ErrorVariable* parameter, you can still get to the *Error Record* of an error.

$Error is an array, too. The most current error always ends up as the first entry (with the index 0) and all other errors move up their position once. The number of errors stored is limited to ensure enough storage space when many errors are recorded. The maximum number is set in *$MaximumErrorCount*.

Error Record Through Traps

Finally, the *Trap* statement also offers a way to get to the current *Error Record*. Access is gained through the *$_* variable inside the *Trap* statement, and you could use *Trap* to generate your own error messages very easily:

```
Trap {"Oops, error: $($_.Exception.Message)";Continue} `
  Del nosuchthing -ea Stop

  Oops, error: Command execution stopped because the shell variable
  "ErrorActionPreference" is set to Stop: Cannot find path
  "C:\Users\Tobias Weltner\nosuchthing" because it does not exist.
```

Understanding Exceptions

"Exceptions" are not everyday occurrences. In the contemporary IT world, the terms "errors" or "bugs" tend to be avoided. Instead, a more elegant word, "exception," is used. When an error occurs, an exception is thrown and has to be "remedied." Either the command responsible for the error rectifies the error or the exception escalates and it has to be remedied at the next-highest level. If nobody tackles the error, it will end up highlighted in red in the PowerShell console.

Because there are different types of exceptions, it is interesting to examine the exception type of an error more closely. This is a way for you to initiate different actions according to the approximate cause of an error. Take a look at how you can flush the exception of an error out into the open:

```
# List exception type of the last error:
$error[0].Exception.GetType().Name
```

```
    RuntimeException

  # Output all exception types for all errors in this PS session:
  $error | Foreach-Object { $_.Exception.GetType().FullName }

    System.Management.Automation.CommandNotFoundException
    System.Management.Automation.RuntimeException
    System.Management.Automation.ItemNotFoundException
    You cannot use the NULL value to call a method for an expression.
    At line:1 char:47
    + $error | Foreach-Object { $_.Exception.GetType( <<<< ).FullName }
```

Both examples presuppose that errors were actually listed previously, because otherwise *$error* would be null.

note When you get errors in the listing that complain about a *NULL* value, then you'll know that some error records are contained in *$error* that were not thrown by an exception.

Handling Particular Exceptions

The code set by *Trap* is normally executed for any exception. As you've just seen, there are exception groups, and if you'd prefer to use one or several groups of different error handlers, go ahead. Just write several *Trap* statements and specify for each the type of exception for which the statement is responsible:

```
  function Test
  {
    Trap [System.DivideByZeroException] {
      "Divided by null!"; Continue
    }
    Trap [System.Management.Automation.ParameterBindingException] {
      "Incorrect parameter!"; Continue
    }
    1/$null
    Dir -MacGuffin
  }
  Test

    Divided by null!
    Incorrect parameter!
```

Throwing Your Own Exceptions

If you're writing your own functions or scripts, sooner or later you'll want to output your own error messages in them. You should never output unchangeable error messages to enable your functions and scripts to be inserted like building blocks in PowerShell just like all the previous cmdlets and functions you've already seen.,. Instead, it would be better to use *Throw* to throw exceptions and to leave it up to the system to handle your exception.

```
function TextOutput([string]$text)
{
  If ($text -eq "")
  {
    Throw "You have to enter some text."
  }
  Else
  {
    "OUTPUT: $text"
  }
}
# An error message will be thrown if no text is entered:
TextOutput

  You have to enter some text.
  At line:5 char:10
  +      Throw  <<<< "You have to enter some text."

# No error will be output in text output:
TextOutput Hello

  OUTPUT: Hello
```

Of course, you already know from your reading of Chapter 9 that it's best for you to define error messages about the arguments of a function as default values. The previous example was supposed to be just a general demonstration of how exceptions are thrown inside a function. If the objective is merely to validate the correct arguments, the function can be simplified considerably:

```
function TextOutput([string]$text = $(Throw "You have to enter some text."))
{ "OUTPUT: $text" }
```

But the main thing is that your function should not output its own error messages in the event of a fault, but instead throw an exception. That leaves it up to the user of the function to decide what to do with the exception you have thrown:

```
Trap { "Oh, an error."; Continue} ; TextOutput

  Oh, an error.
```

Catching Errors in Functions and Scripts

Error handling basically works in your own functions or scripts just as it does in the console. Use traps if you want to catch errors. In this connection, it isn't important where you exactly situate the *Trap* statement. No matter if you put the statement at the beginning or at the end, as soon as an error occurs inside the function, the *Trap* statement code will be executed. This means that the following two functions would behave in exactly the same way:

```
function malfunction1
{
  Trap { "An error occurred." }
  1/$null
  Get-Process "nosuchthing"
  Dir xyz:
}
malfunction1

  An error occurred.
  Attempted to divide by zero.
  At line:3 char:5
  +   1/$ <<<< null
  Get-Process : Cannot find a process with the name "nosuchthing".
  Verify the process name and call the cmdlet again.
  At line:4 char:14
  +   Get-Process  <<<< "nosuchthing"Get-ChildItem : Cannot find drive.
  A drive with name "xyz" does not exist.
  At line:5 char:6
  +   Dir  <<<< xyz:
```

The result of the function example is interesting and confusing at the same time. The first statement inside the function doesn't cause an error. That's why the code after *Trap* is executed and returns the error message "An error occurred". PowerShell's error message follows afterwards because *ErrorAction* is not set to *SilentlyContinue*. The remaining two faulty commands are also executed. To be precise, they are executed this time without renewed execution of the *Trap* block.

You already know the reason why: *Trap* can only capture errors that it can see. Cmdlets use the standard setting *Continue* as *ErrorAction*. In this setting, cmdlets do not report errors to the caller but handle errors themselves. If you'd like your trap to deal with such errors, you must reset *ErrorAction* to *Stop*:

```
function malfunction1
{
  Trap { "An error occurred."}
  1/$null
  Get-Process "nosuchthing" -ea Stop
  Dir xyz: -ea Stop
}
malfunction1

  An error occurred.
  Attempted to divide by zero.
```

```
    At line:4 char:5
    +   1/$ <<<< null
    An error occurred.
    Get-Process : Command execution stopped because the shell variable
    "ErrorActionPreference" is set to Stop: Cannot find a process with
    the name "nosuchthing". Verify the process name and call the cmdlet again.
    At line:5 char:14
    +   Get-Process  <<<< "nosuchthing" -ea Stop
    An error occurred.
    Get-ChildItem : Command execution stopped because the shell variable
    "ErrorActionPreference" is set to Stop: Cannot find drive. A drive with
    name "xyz" does not exist.
    At line:6 char:6
    +   Dir  <<<< xyz: -ea Stop
```

Now, the function works the way it was expected to originally. The trap is called for every single error. However, internal PowerShell error messages are still generated subsequently. Error messages will no longer appear if you use *Continue* to instruct your trap to keep on going after the error. Your trap should return an explanatory comment so that you can also find out which error actually occurred.

```
  function malfunction1
  {
    Trap {"Oops, error: $($_.Exception.Message)";Continue}
    1/$null
    Get-Process "nosuchthing" -ea Stop
    Dir xyz: -ea Stop
  }
  malfunction1

    Oops, error: Attempted to divide by zero.
    Oops, error: Command execution stopped because the
    shell variable "ErrorActionPreference" is set to Stop:
    Cannot find a process with the name "nosuchthing". Verify
    the process name and call the cmdlet again.
    Oops, error: Command execution stopped because the
    shell variable "ErrorActionPreference" is set to Stop: Cannot find drive. A drive
    with name "xyz" does not exist.
```

If you would prefer that the function stops when the first error occurs, you should use the *Break* statement inside *Trap*: instead of *Continue.*

```
  function malfunction1
  {
    Trap {"Oops, error: $($_.Exception.Message)"; Break}
    1/$null
    Get-Process "nosuchthing" -ea Stop
    Dir xyz: -ea Stop
  }
  malfunction1

    Oops, error: Attempted to divide by zero.
    Attempted to divide by zero.
    At line:4 char:5
    +   1/$ <<<< null
```

Now the function is stopped when the first error occurs, but the internal PowerShell message turns up again after your own error message. *Break* does stop execution in the current area, but does this by throwing the original error again and letting PowerShell handle it. This means that when you use *Break* you'll always get the PowerShell error message.

If you would prefer that a function stops after the first error without PowerShell adding its own error message, you must do without *Break* and understand a little better what the *Continue* statement is actually doing. *Continue* carries on execution after an error with the next statement that is in the same area as *Trap*. So, if the *Trap* statement is inside your function, and if an error occurs, then *Continue* would carry on with the next command inside the function. However, you must move *Trap* to the parent area since you want the function to stop after the first faulty command. You could call the function from within a second function:

```
  function Caller
  {
    Trap {"Oops, error: $($_.Exception.Message)"; Continue}
    malfunction
  }
  function malfunction
  {
    1/$null
    Get-Process "nosuchthing" -ea Stop
    Dir xyz: -ea Stop
  }
  Caller

    Oops, error: Attempted to divide by zero.
```

Now the sequence of operations functions as requested. *Trap* recognizes the first error in the *Malfunction* function and because of *Continue* carries on execution with the next statement: not with the next statement in *Malfunction* but with the next statement in *Caller*, because that's where *Trap* was defined.

Of course, this type of call is little peculiar. Do you really have to bother about a second separate caller function just so you can stop a function when the first error occurs and take care of the error yourself? You don't. You just need to make sure that the *Trap* statement is in another area than the one in which the rest of the function is located. For example, you could define an additional one inside your function and then call it:

```
  function malfunction
  {
    # Trap is defined in the outer area of the function:
    Trap {"Oops, error: $($_.Exception.Message)"; Continue}
    # The rest of the function is your own
    function InnerCore
    {
      1/$null
      Get-Process "nosuchthing" -ea Stop
      Dir xyz: -ea Stop
    }
    InnerCore
  }
```

note It is indeed possible for you to nest functions in PowerShell. The *InnerCore* function is then a private function that is valid only inside the *Malfunction* function. However, it does not suffice to only define the *InnerCore* function, which naturally must also be specifically called so that it completes its task. Because the faulty lines now run in their own encapsulated function and *Trap* is defined outside it, *Continue* doesn't execute the next statement in *InnerCore* but the next statement in *Malfunction*.

In the next chapter, you'll find out in detail how PowerShell really implements functions. You'll learn more about scriptblocks. You don't necessarily have to create your own nested subfunctions. It suffices for you to put critical instruction lines in their own scriptblock and to use the call operator "&" to execute the block:

```
function malfunction
{
  # Trap is defined in the outer area of the function:
  Trap {"Oops, error: $($_.Exception.Message)"; Continue}
  # The rest of the function is in its own scriptblock
  # that is immediately executed by using "&":
  & {
    1/$null
    Get-Process "nosuchthing" -ea Stop
    Dir xyz: -ea Stop
  }
}
malfunction

  Oops, error: Attempted to divide by zero.
```

Stepping Through Code: Breakpoints

You can stop PowerShell code inside your functions and scripts at any point to see whether everything is working the way it should. To do so, use breakpoints, which are nothing more than commands. In less complicated cases, you can input the breakpoint command right in the PowerShell console:

```
Write-Debug "I'll just stop for a moment."
```

Surprisingly, this command appears to have no effect whatsoever. Nothing happens. The reason is that the *$DebugPreference* variable is set as default for the *"SilentlyContinue"* variable. *"SilentlyContinue"* corresponds exactly to what you've already seen it do: output nothing, continue. As long as *$DebugPreference* is set to this value, debugging is turned off. If you want to turn it on, set *$DebugPreference* to another one of the values listed in Table 11.4.

Setting	**Description**
SilentlyContinue	Debugging is turned off
Stop	Execution is stopped because debugging makes less sense
Continue	Debugging information is output and the statement immediately continued
Inquire	You receive the selection and, you can temporarily suspend execution to examine your code

Table 11.4: Settings for $DebugPreference

There you have the tools you need for a little debugging kit:

- **Installing breakpoints:** Use *Write-Debug* at all locations inside a function or a script that you want to monitor more closely and have *Write-Debug* output useful comments.
- **Simple debugging: S**witch *$DebugPreference* to *"Continue"* so that *Write-Debug* will output its comments, allowing you to follow the sequence of code operations.
- **Extended debugging:** Switch *$DebugPreference* to *"Inquire"* so that *Write-Debug* works like a real breakpoint. Execution is then stopped for every *Write-Debug*, and you can use the suspend option to get back to a prompt and from there use customary PowerShell commands, such as to verify the contents of variables. Execution will be continued as soon as you type the exit command.
- **Turning off debugging again:** If you would like to stop debugging again, simply set *$DebugPreference* to the initial value *"SilentlyContinue"*. All Write-Debug statements will immediately be ignored so that you won't need to remove these statements. Perhaps you would like to debug the code later again. As long as *$DebugPreference* is set to *"SilentlyContinue"*, these statements will have no effect.

The following loop shows how your breakpoints will respond to different settings for *$DebugPreference*. If you use the default for execution, 10 numbers will be output:

```
For ($i=0; $i -lt 10; $i++) { Write-Debug "Counter is at $i"; $i }

    0
    1
    2
    3
    (...)
```

If you turn on simple debugging, the *Write-Debug* comments will be highlighted in yellow:

```
  $Debug-Preference = "Continue"
  For ($i=0; $i -lt 10; $i++) { Write-Debug "Counter is at $i"; $i }

    DEBUG: Counter is at 0
    0
    DEBUG: Counter is at 1
    1
    DEBUG: Counter is at 2
    2
    (...)
```

By using extended debugging, you can convert *Write-Debug* statements into genuine breakpoints. You could also interrupt execution, inspect variables, and even make changes. As soon as you enter the *Exit* command, execution will continue:

```
  # Activate full debugging:
  $Debug-Preference = "Inquire"
  For ($i=0; $i -lt 10; $i++) { Write-Debug "Counter is at $i"; $i }

    DEBUG: Counter is at 0
    Confirm
    Continue with this operation?
    |Y| Yes  |A| Yes to All   |B| Suspend command  |S| Suspend  |?| Help (default is
    "J"):

  (H)
  >>
  # Execution is suspended; you may inspect variables and make changes:
  >> $i

    0

  >> $i=7
  >> # Use the Exit command to continue execution
  >> exit

    Confirm
    Continue with this operation?
    |Y| Yes  |A| Yes to All   |B| Suspend command  |S| Suspend  |?| Help (default is
    "Y"):

  (A)

    7
    (...)
```

Aside from the automatic variable *$DebugPreference*, which you can use to determine whether and how debugging messages are output, there are a number of additional automatic variables that work in a similar way and define how PowerShell should respond if you make no further specifications (Table 11.5).

Variable	**Description**
ConfirmPreference	Specifies when confirmation should be requested. Confirmation is requested when "ConfirmImpact" of the operation is greater than or equal to "$ConfirmPreference". If "$ConfirmPreference" is set to "None", actions will be confirmed only if "Confirm" is specified.
DebugPreference	Specifies the action to take when a debugging message is conveyed.
ErrorActionPreference	Specifies the action to take when an error message is conveyed.
ErrorView	Specifies the display mode for showing errors.
ProgressPreference	Specifies the action to take when status files are conveyed.
ReportErrorShowExceptionClass	Results in display of errors with a description of the exception class.
ReportErrorShowInnerException	Results in display of errors with inner exceptions.
ReportErrorShowSource	Results in display of errors with cause of errors.
ReportErrorShowStackTrace	Results in display of errors with stack trace.
VerbosePreference	Specifies the action to take when a detailed message is conveyed. Permitted values are "SilentlyContinue", "Stop", "Continue" and "Inquire".

WarningPreference	Specifies the action to take when a warning message is conveyed.
WhatIfPreference	If "true", "WhatIf" is regarded as enabled for all commands.

Table 11.5: Fine adjustments of the PowerShell console

Tracing: Displaying Executed Statements

You don't necessarily have to insert debugging statements into your code since sometimes it's not your code that is even being executed. .However, you do have the option to enable tracing. This allows PowerShell to output each statement automatically as a debugging message. The cmdlet *Set-PSDebug* manages tracing.

```
Set-PSDebug -trace 1
Dir *.txt

  DEBUG:    1+ Dir *.txt
  DEBUG:    1+ $_.PSParentPath
  DEBUG:    1+ $catr = "";
  DEBUG:    2+ If ( $this.Attributes -band 16 ) { $catr += "d" }
                Else { $catr += "-" } ;
  DEBUG:    2+ If ( $this.Attributes -band 16 ) { $catr += "d" }
                Else { $catr += "-" } ;
  DEBUG:    3+ If ( $this.Attributes -band 32 ) { $catr += "a" }
                Else { $catr += "-" } ;
  DEBUG:    3+ If ( $this.Attributes -band 32 ) { $catr += "a" }
                Else { $catr += "-" } ;
  DEBUG:    4+ If ( $this.Attributes -band 1 )  { $catr += "r" }
                Else { $catr += "-" } ;
  DEBUG:    4+ If ( $this.Attributes -band 1 )  { $catr += "r" }
                Else { $catr += "-" } ;
  DEBUG:    5+ If ( $this.Attributes -band 2 )  { $catr += "h" }
                Else { $catr += "-" } ;
  DEBUG:    5+ If ( $this.Attributes -band 2 )  { $catr += "h" }
                Else { $catr += "-" } ;
  DEBUG:    6+ If ( $this.Attributes -band 4 )  { $catr += "s" }
                Else { $catr += "-" } ;
  DEBUG:    6+ If ( $this.Attributes -band 4 )  { $catr += "s" }
                Else { $catr += "-" } ;
  DEBUG:    7+ $catr
  DEBUG:    2+ [String]::Format("{0,10}  {1,8}", $_.LastWriteTime.
                ToString("d"), $_.LastWriteTime.ToString("t"))
      Directory: Microsoft.PowerShell.Core\FileSystem::C:\Users\Tobias Weltner
  Mode                LastWriteTime     Length Name
  ----                -------------     ------ ----
```

```
    -a---        19.09.2007      14:30       13386 output.txt
```

Here, PowerShell lists the PowerShell code of the ScriptProperty *Mode*, which is executed when you output a directory listing.

Simple tracing will show you only PowerShell statements executed in the current context. If you invoke a function or a script, only the invocation will be shown but not the code of the function or script. If you would like to see the code, turn on detailed traced by using the *-trace 2* parameter.

```
Set-PSDebug -trace 2
```

If you would like to turn off tracing again, select 0:

```
Set-PSDebug -trace 0
```

Stepping: Executing Code Step-by-Step

You don't even need your own breakpoints to run PowerShell code one step at a time. Just turn on automatic stepping:

```
Set-PSDebug -step
```

From then on, PowerShell will ask you when every single statement is displayed whether you want to execute the statement, skip it, or temporarily suspend the code.

If you choose *Suspend* by pressing "H", you will end up in a nested prompt, which you will recognize by the ">>" sign at the prompt. The code will then be interrupted so you could analyze the system in the console or check variable contents. As soon as you enter *Exit*, execution of the code will continue. Just select the "A" operation for "Yes to All" in order to turn off the stepping mode.

By the way, you can also create your own breakpoints by using nested prompts: call *$host.EnterNestedPrompt()* inside a script or a function.

note

Set-PSDebug has another important parameter called *-strict*. It ensures that unknown variables will throw an error. Without the *Strict* option, PowerShell will simply set a null value for unknown variables.

Summary

By using "what-if" scenarios, you can validate the consequences of commands in safe dry runs. One option is to specify the *-whatif* parameter if you'd like to see what a command might do. The other option is to specify the *-Confirm* parameter if you would like to confirm every single operation manually before execution (Table 11.1). Most cmdlets support both parameters so you can reproduce this functionality in your own functions or scripts by using self-defined switch parameters.

Code in functions and scripts can be provided with debugging messages and breakpoints for diagnostic purposes. Insert *Write-Debug* statements into the code and use *$DebugPreference* to determine whether *Write-Debug* outputs a message or is actually supposed to suspend the code at the location (Table 11.4). If the code is suspended, you can make a detailed examination of the variables of your function or script in the console. Type *Exit* when you end the breakpoint and want to continue execution of code.

PowerShell includes other automatic variables that enable you to determine whether and when commands have to be confirmed and how detailed error reports should be (Table 11.5). Among these variables is *$ErrorActionPreference*, which you can use to specify whether PowerShell should continue execution even if errors occur, or stop execution. The default setting does not stop execution when errors occur unexpectedly.

You can evaluate a number of variables if you prefer responding to errors yourself. The *$?* variable contains *$false* if the last command caused an error. PowerShell lists error details in the *$error* array, in which every error is stored as an *Error Record*.

You can gain more control over errors by using traps, which are statements executed when an error occurs. So that traps work, the error really must throw an exception and may not be caught by the command that caused it. For this reason, traps can react to errors only if you have previously switched *ErrorAction* from *Continue* to *Stop*.

Within the code after *Trap*, you'll be provided with all the details on the current error in the *$_* variable, which contains the *Error Record* of the error. Your *Trap* statement can also use the *Break* and *Continue* statements to determine what will happen next. If you specify *Break*, then execution will be ended in the code block where *Trap* is defined. PowerShell will output the error message of the current error. If you specify *Continue*, PowerShell will continue execution with the next statement in the same block where *Trap* is defined. PowerShell will not output any error message.

CHAPTER 12.

Command Discovery and Scriptblocks

In previous chapters you learned step by step how to use various PowerShell command types and mechanisms. After 11 chapters, we have reached the end of the list. You'll now put together everything you've seen. All of it can actually be reduced to just two PowerShell basic principles: *command discovery* and *scriptblocks*.

The purpose of this chapter is to tie up the many loose ends of previous chapters and to weave them into a larger whole: the basics are complete and the remaining chapters will put the knowledge gained to the test of daily tasks.

Topics Covered:

Command Discovery

From the user's point of view, it's rather easy to assign tasks to PowerShell: you type the command in the console, press (Enter), and the command is immediately carried out. But much more complex things are happening behind the scenes. PowerShell has to first find out which command you actually meant. This operation is called *command discovery* and is usually performed automatically. Use the *Get-Command* cmdlet if you want to run command discovery yourself to understand what is actually taking place.

If you'd like to know what the *Dir* command actually is, pass it to *Get-Command*:

```
Get-Command Dir

  CommandType     Name  Definition
  -----------     ----  ----------
  Alias           Dir   Get-ChildItem
```

Get-Command correctly identifies your command in the *CommandType* column as *Alias* and reports in the *Definition* column which actual command PowerShell invoked. Basically, this is the way it functions for all commands—even if you invoke the external programs:

```
Get-Command ping

  CommandType     Name      Definition
  -----------     ----      ----------
  Application     PING.EXE  C:\Windows\system32\PING.EXE
```

This time the *CommandType* column reports the *Application* type, and in the definition the exact path is output to the external program.

In fact, *Get-Command* returns a *CommandInfo* object that contains much more information. From Chapter 5 you know how to make all object properties visible: send the object to a formatting cmdlet like *Format-List* and type an asterisk after it:

```
# Get-Command returns a CommandInfo object that exists
# in various subtypes:
$info = Get-Command ping
$info.GetType().FullName

  System.Management.Automation.ApplicationInfo

# Send the object to Format-List and append an asterisk
# to see all properties:
$info | Format-List *

  FileVersionInfo : File:             C:\Windows\system32\PING.EXE
                    InternalName:     ping.exe
                    OriginalFilename: ping.exe.mui
                    FileVersion:      6.0.6000.16386 (vista_rtm.061101-2205)
                    FileDescription:  TCP/IP Ping Command
                    Product:          Microsoft® Windows® operating system
```

```
                     ProductVersion:   6.0.6000.16386
                     Debug:            False
                     Patched:          False
                     PreRelease:       False
                     PrivateBuild:     False
                     SpecialBuild:     False
                     Language:         English (United States)
Path               : C:\Windows\system32\PING.EXE
Extension          : .EXE
Definition         : C:\Windows\system32\PING.EXE
Name               : PING.EXE
CommandType        : Application
```

Command discovery gets really interesting when there are several commands that have the same name. The question is which of these commands PowerShell is executing:

```
Get-Command more

  CommandType     Name      Definition
  -----------     ----      ----------
  Function        more      param([string[]]$paths);  If(($paths -ne...
  Application     more.com  C:\Windows\system32\more.com
```

As you see, there are two commands called *more*. One is a PowerShell function (*CommandType: Function*) and the other an external program called *more.com* (*CommandType: Application*). If you use *more* as a command, PowerShell will automatically choose the one it uses based on its own internal priority list from among several commands having the same name. Because PowerShell functions have a higher priority than external applications, the internal PowerShell functions will always be the first in line:

```
Dir | more
```

If you'd prefer using the external program *more.com*, you must specify it explicitly:

```
Dir | more.com
```

That works because if you specify the command name *more.com* there's no danger of confusing the names:

```
Get-Command more.com

  CommandType     Name      Definition
  -----------     ----      ----------
  Application     more.com  C:\Windows\system32\more.com
```

However, there's no guarantee because there could be an alias called *more.com* on your system. That's why you'll soon learn better methods to execute exactly the command you want to execute with utter precision. But first you'll have to know how PowerShell actually invokes commands.

The Call Operator "&"

The little call operator "&" gives you great discretionary power over the execution of PowerShell commands. If you place this operator in front of a string (or a string variable), the string will be interpreted as a command and executed just as if you had input it directly into the console.

```
# Store a command in a variable:
$command = "Dir"
# If you output the contents of the variable,
# only string will be output:
$command
Dir
# If you type the call operator "&" in front of it,
# the command will be executed:
& $command


  Directory: Microsoft.PowerShell.Core\FileSystem::C:\Users\Tobias Weltner
  Mode       LastWriteTime  Length Name
  ----       -------------  ------ ----
  d----  10.01.2007  16:09         Application Data
  d----  07.26.2007  11:03         Backup
  (...)
```

tip The call operator also comes to the rescue when the command name contains special characters like white space and can't be input directly into the console. Put the name in quotation marks to turn it into string and use the call operator to run it:

```
& "A command with whitespace"
```

The Call Operator Only Accepts Single Commands

However, the call operator won't run an entire instruction line but always precisely one command. If you had assigned not just a single command, like *Dir* in the variable but several commands, or if you had also specified arguments for the command, an error would have been generated:

```
$command = "Dir C:\"
& $command

  The term "Dir c:\" is not recognized as a cmdlet, function,
  operable program, or script file. Verify the term and try again.
  At line:1 Char:2
  + &  <<<< $command
```

Why is that? The reason: in the murky depths of PowerShell, the call operator calls *Get-Command* to find out what it is supposed to actually be running. *Get-Command* always gets only a single command, never entire instruction lines:

```
# A single command is recognized correctly:
Get-Command "Dir"

  CommandType     Name        Definition
  -----------     ----        ----------
  Alias           Dir         Get-ChildItem

# A command with arguments or several commands is not recognized:
Get-Command "Dir C:\"

  Get-Command : The term "Dir c:\" is not recognized as a
  cmdlet, function, operable program, or script file. Verify
  the term and try again.
  At line:1 Char:12
  + Get-Command  <<<< "Dir C:\"
```

The Call Operator Executes CommandInfo Objects

The call operator initially passes what you specify as a command to *Get-Command,* which returns a *CommandInfo* object that the call operator then executes. In fact, the call operator can also accept a *CommandInfo* object directly and save itself the roundabout *Get-Command*:

```
# Get the CommandInfo object of a command:
$command = Get-Command ping
$command

  CommandType     Name        Definition
  -----------     ----        ----------
  Application     PING.EXE    C:\Windows\system32\PING.EXE

# Use the call operator "&" to call the CommandInfo object:
& $command -n 1 -w 100 10.10.10.10

  Pinging 10.10.10.10 with 32 bytes of data:
  Reply from 10.10.10.10: Bytes=32 Time<1ms TTL=128
  Ping statistics for 10.10.10.10:
  Packets: Sent = 1, Received = 1, Lost = 0 (0% Loss),
  Ca. time in millisec:
  Minimum = 2ms, Maximum = 2ms, Average = 2ms
```

note

The & *$command* calls the command in *$command*. You may specify any arguments after it, but you can't wrap the arguments directly in *$command* because the call operator always executes only one single command without arguments.

```
# not allowed:
& "Dir C:\"
```

Did you just have a little dÃ©jÃ -vu experience? Aliases behave exactly the same way and can provide only single commands under another name, but not commands with arguments. Aliases are nothing more than named call operators. If you input the alias, PowerShell will internally invoke the call operator for the command that you assigned to the alias.

Identically Named Commands: Which is Running?

PowerShell supports a great many commands of the most diverse types, cmdlets, functions, aliases, or external commands. Within this range of command types, command names should not be ambiguous as there can never be more than one function or alias having the same name. However, among the various command types, names can be identical; usually, that's even highly desirable.

If there are several commands having identical names, PowerShell will examine its own internal priority list (Table 12.1) and decide which command will be executed. For example, you can use aliases to set up "command redirection" because aliases have a higher priority than external programs.

```
# Run an external command:
ping -n 1 10.10.10.10

  Pinging 10.10.10.10 with 32 bytes of data:
  Reply from 10.10.10.10: Bytes=32 Time<1ms TTL=128
  Ping statistics for 10.10.10.10:
  Packets: Sent = 1, Received = 1, Lost = 0 (0% Loss),
  Ca. time in millisec:
  Minimum = 2ms, Maximum = 2ms, Average = 2ms

# Create a function having the same name:
function Ping { "Ping is not allowed." }
# Function has priority over external program and turns off command:
ping -n 1 10.10.10.10

  Ping is not allowed.
```

PowerShell functions have a higher priority than external commands, and that's why PowerShell has executed its new *Ping* function instead of the old *Ping* command. You have seemingly brought the *Ping* command to a halt. Instead of a function, you could also have created an alias, which has an even higher priority so that your newly created function would then no longer be invoked.

```
Set-Alias ping echo
ping -n 1 10.10.10.10

  -n
```

```
1
10.10.10.10
```

Now, *Ping* calls the *Echo* command, which is an alias for W*rite-Output* and simply outputs the parameters that you may have specified after *Ping* in the console.

If you'd like to see all the commands of a particular type, specify the *-commandType* parameter. The next statement lists all commands of the *Filter* type:

```
Get-Command -commandType Filter
```

CommandType	Description	Priority
Alias	An alias for another command added by using *Set-Alias*	1
Function	A PowerShell function defined by using *function*	2
Filter	A PowerShell filter defined by using *filter* (a function with a *process* block)	2
Cmdlet	A PowerShell cmdlet from a registered snap-in	3
Application	An external Win32 application	4
ExternalScript	An external script file with the file extension ".ps1"	5
Script	A scriptblock	-

Table 12.1: Various PowerShell command types

If you enter the *Ping* command in this example, *Get-Command* will first find out which commands are possible:

```
Get-Command Ping

  CommandType     Name       Definition
  -----------     ----       ----------
  Function        Ping       "Ping is not allowed."
  Alias           ping       echo
  Application     PING.EXE   C:\Windows\system32\PING.EXE
```

Based on the internal PowerShell priority list, the command of the alias type is selected from these three commands and executed. If you'd rather run another *Ping* command, you will have to circumvent automatic selection.

You've seen that the call operator accepts commands in two ways: either as a string (in which case it tasks Get-Command with automatically choosing an appropriate command) or as a *CommandInfo* object (in which case it is clear which command is meant). So, if you'd like to run a particular command yourself, get its *CommandInfo* object. That will retrieve *Get-Command*. If you'd like to run the original *Ping* command, the third array element is suitable:

```
# Get all commands named "Ping":
$commands = Get-Command Ping
# Call the third command (array index 2):
& $commands[2] -n 1 10.10.10.10

  Pinging 10.10.10.10 with 32 bytes of data:
  Reply from 10.10.10.10: Bytes=32 Time<1ms TTL=128
  Ping statistics for 10.10.10.10:
  Packets: Sent = 1, Received = 1, Lost = 0 (0% Loss),
  Ca. time in millisec:
  Minimum = 2ms, Maximum = 2ms, Average = 2ms
```

However, calling by means of an array index is usually not a good idea because you don't know whether several identically named commands exist, and if they do, in which order the commands were defined. It's better to specify right from the beginning the type you want, which *Get-Command* always reports in the *CommandType* column. Name conflicts are out of the question because there can be only one command having a particular name for each type.

The original *Ping* command is of the *Application* type. So, if you'd like to invoke this command, instruct *Get-Command* to retrieve for you the *Ping* command of the *Application* type. It shouldn't be important to you at all whether there are any other identically named commands of other types. PowerShell will start the original *Ping* command in any case:

```
# Return and then start the "Ping" command of the "Application" type:
$command = Get-Command -commandType Application Ping
& $command -n 1 10.10.10.10

  Pinging 10.10.10.10 with 32 bytes of data:
  Reply from 10.10.10.10: Bytes=32 Time<1ms TTL=128
  Ping statistics for 10.10.10.10:
  Packets: Sent = 1, Received = 1, Lost = 0 (0% Loss),
  Ca. time in millisec:
  Minimum = 2ms, Maximum = 2ms, Average = 2ms

# Call in only one line:
& (Get-Command -commandType Application Ping) -n 1 10.10.10.10

  Pinging 10.10.10.10 with 32 bytes of data:
  Reply from 10.10.10.10: Bytes=32 Time<1ms TTL=128
  Ping statistics for 10.10.10.10:
  Packets: Sent = 1, Received = 1, Lost = 0 (0% Loss),
  Ca. time in millisec:
    Minimum = 2ms, Maximum = 2ms, Average = 2ms
```

You now know how PowerShell finds out which command is supposed to be run and how you can use the call operator to invoke your own commands. However, the call operator does have one nasty limitation: it can never execute more than one single command, nor can it execute any instruction lines, nor commands with arguments. If the call operator is calling the shots behind the scenes, how can it execute the entire instruction lines that you type in the console? To clear that up, you'll need another very important PowerShell basic element - scriptblocks.

Using Scriptblocks

The scriptblock is a special form of command. The scriptblock can contain as much PowerShell code as you like. It is defined by braces. The smallest possible scriptblock is just the minimal amount of PowerShell code in braces. You can use the previously described call operator to execute a scriptblock:

```
  & { "Today's date: " + (get-date) }

    Today's date: 10/07/2007 12:32:39
```

Executing Entire Instruction Lines

Perhaps you're beginning to realize how scriptblocks enable the call operator to execute not just single commands, but entire instruction lines. The call operator normally runs just single commands, but among the permitted commands, according to Table 12.1, are commands of the script type, the scriptblocks. This is the solution to running whole lines of instructions since scriptblocks can consist of any number of commands. In the next example, the call operator runs several statements in the line:

```
  # The call operator "&" can run several commands
  # if these are enclosed in braces:
  & {Get-Process | Where-Object { $_.Name -like 'a*'}}
```

This is the way command entry works in the PowerShell console: if you type an instruction line in the console, PowerShell will turn the line into a scriptblock and execute it just the way it did in the previous example. Scriptblocks are the universal basic element of PowerShell. Many PowerShell commands and structures, upon closer examination, are nothing more than scriptblocks. Let's take a look at all the places where scriptblocks are hidden in PowerShell.

Invoke-Expression

You've seen above that the call operator can process whole instruction lines with the help of a scriptblock. Actually, this function corresponds to the *Invoke-Expression* cmdlet, which is nothing more than a scriptblock that is passed to the call operator:

```
  Invoke-Expression 'Get-Process | Where-Object { $_.Name -like "a*"}'
```

```
Handles  NPM(K)    PM(K)      WS(K) VM(M)   CPU(s)     Id ProcessName
-------  ------    -----      ----- -----   ------     -- -----------
     36       2      712         48    21            2616 agrsmsvc
    311       9    10988       3324   112             464 AppSvc32
    105       3     1044        736    37            1228 Ati2evxx
    130       5     2056       3916    48            1732 Ati2evxx
     79       4     4612       1092    58     2,75   2064 ATSwpNav
     99       3    11892       7600    45            1432 audiodg
```

note

Just remember to put code after *Invoke-Expression* in single quotation marks. If you use double quotation marks, PowerShell will replace all the variable names in the string with the variable contents. Because part of the *$_* variable in the last example is part of the code to be executed, it would be incorrectly replaced with "null" and generate an error:

```
# Don't enclose the string after Invoke-Expression
# in double quotation marks:
Invoke-Expression "Get-Process |
  Where-Object { $_.Name -like 'a*'}"

  The term ".Name" is not recognized as a cmdlet,
  function, operable program, or script file. Verify
  the term and try again.
  At line:1 Char:35
  + Get-Process | Where-Object { .Name  <<<< -like 'a*'}
```

The following statement is completely identical:

```
& {Get-Process | Where-Object { $_.Name -like 'a*'}}
```

Pipeline: ForEach-Object

In Chapter 5, you used the *ForEach-Object* cmdlet in the pipeline, which loops over every pipeline object one by one. PowerShell code follows *ForEach-Object* in braces, so it is actually a scriptblock. The following scriptblock was executed for every object in the pipeline:

```
Get-Process | ForEach-Object { $_.name }
```

Loops: If and For

Do you remember Chapter 7? You worked with conditions, which also use scriptblocks, as they do in this example:

```
$age = 21
If ($age -lt 21)
```

```
{
  "You're too young."
}
Else
{
  "You may drink a wine."
}
```

The *If* statement uses two scriptblocks. The first is executed if the condition after *If* is met; the second, if it is not met. You saw much the same thing for the loops in Chapter 8:

```
For ($x=1; $x -le 10; $x++)
{
  $x
}
```

Again, here's a scriptblock in braces that iterates until the termination condition of the loop is met.

Functions Are Named "Scriptblocks"

A new light is shed on the functions from Chapter 9, because functions and scriptblocks are basically identical. Functions are nothing more than *named* scriptblocks that you can call directly through a set name. Take a look:

```
function Test { "Hello world!" }
```

The identifier *function* sets a name for the scriptblock that follows it in braces. That's why this scriptblock will be run when you specify the assigned name:

```
Test

  Hello world!
```

You can see that the function actually consists of just one conventional scriptblock when you get the scriptblock of the function:

```
$scriptblock = $function:Test
$scriptblock

  "Hello world!"

$scriptblock.GetType().Name

  ScriptBlock
```

You could reprogram the function by allocating another scriptblock to it:

```
# Allocate scriptblock in braces:
$function:Test = { "Morning!" }
Test
```

```
  Morning!

# String will be automatically changed to a scriptblock type:
$function:Test = ' "Morning!" '
Test

  Morning!

# Don't use braces inside a string:
$function:Test = "{ 'Morning!' }"
Test

  'Morning!'
```

tip

Just remember not to use braces in a string. If you do anyway the braces will not delimit the scriptblock but ensure that any special characters in the string are not evaluated as special characters. That's why the *Test* function in the last example outputs a string along with the quotation marks.

If you like, you could use your newly acquired skills to even create functions entirely without the *Function* statement:

```
# Directly create a new function:
New-Item function:newFunction -value {"Hello world!"} -force

  CommandType     Name            Definition
  -----------     ----            ----------
  Function        newFunction     "Hello world!"

newFunction

  Hello world!
```

Building Scriptblocks

Because functions are nothing more than named scriptblocks, which support all the features that distinguish functions. Let's see whether that's really true.

Passing Arguments to Scriptblocks

Parameters may be specified in parentheses after the name of a function so that the user of the function can pass additional arguments to it later. The following simple function example defines a parameter called *$text* and outputs only what was passed to the function as an argument:

```
function TextOutput($text)
{
  $text
}
TextOutput "Hello"

  Hello
```

How can a scriptblock offer the same functionality? After all, a scriptblock doesn't have a *function* statement after which you could define a parameter. In reality, every function is only a scriptblock. Have a look here to see how a scriptblock embeds parameters:

```
$function:TextOutput

  param($text) $text
```

A scriptblock uses the *param* statement to define a parameter. Think of Chapter 10 and scripts, which do precisely the same thing. So scripts are also nothing more than scriptblocks, although they tend to be very extensive ones. You could easily define your own *anonymous* scriptblock (i.e., one you don't have to name) that processes arguments. The following scriptblock accepts two parameters and multiplies them:

```
{ param($value1, $value2)  $value1 * $value2 }
```

To invoke the scriptblock, use the call operator again:

```
& { param($value1, $value2)  $value1 * $value2 } 10 5

  50

& { param($value1, $value2)  $value1 * $value2 } "Hello" 10

  HelloHelloHelloHelloHelloHelloHelloHelloHelloHello
```

Begin, Process, End Pipeline Blocks

A further characteristic of functions is their ability to define three blocks called *begin*, *process*, and *end* in order to process PowerShell pipeline results in real time. Do you still remember Chapter 9? If a function is used inside a pipeline, it initially runs code in the begin block, then once again in the process block for every pipeline object, and finally in the end block. If the three blocks aren't defined, the function can't process pipeline results in real time, but blocks the pipeline until all results are available.

Scriptblocks can also define these three blocks and be used in the pipeline. In fact, the *ForEach-Object* cmdlet is basically nothing more than a scriptblock that has in itself a *process* block:

```
# The ForEach-Object cmdlet...
Get-Process | ForEach-Object { $_.Name }
# ...is a scriptblock that has a process block in itself:
Get-Process | & { process { $_.Name } }
```

The *Where-Object* cmdlet works in a similar way:

```
# The Where-Object cmdlet...
Get-Process | Where-Object { $_.Name -like "a*" }
# ...is a scriptblock with a process and a condition:
Get-Process | & { process { If ($_.Name -like "a*") { $_ } } }
```

Validity of Variables

All the variables that are created inside a function are private and valid (only inside the function) unless you expressly specify another validity in the variable name. In the following example, the *Test* function defines two variables. The variable *$value1* is created without any particular validity identifier and consequently is private. This variable is valid only inside the function. On the other hand, the variable *$value2*, is created with the *global:* validity identifier and consequently is also valid outside the function:

```
function Test
{
  $value1 = 10
  $global:value2 = 20
}
Test
$value1
$value2

  20
```

Let's try the same thing with a scriptblock:

```
& { $value1 = 10; $global:value2 = 20 }
$value1
$value2

  20
```

As it turns out, scriptblocks determine the validity of variables. All the variables that you define without any particular validity identifier inside a scriptblock are valid only inside the scriptblock. This behavior is not confined to functions but applies in all scriptblocks invoked by using the "&" call operator. In contrast, PowerShell runs scriptblocks executed inside loops or conditions in the current context. That's why the *$text* variable is valid outside the condition as well:

```
If ($age -ge 18)
{
  $text = "You are of age"
}
Else
{
  $text = "You are under age"
}
$text
```

```
    You are under age
```

ExecutionContext

PowerShell provides a very special object, the automatic variable *$ExecutionContext*, which you will rarely need but which will help you better understand PowerShell internal operations. This object offers two main properties:*InvokeCommand* and *SessionState*.

InvokeCommand

By now, you should be familiar with three important special characters that PowerShell uses in the console. Double quotation marks define not only a string but also ensure at the same time that variable names in the string are replaced with variable contents. The ampersand, "&", is the call operator and runs commands. Finally, braces create new scriptblocks.

In fact, behind these special characters are internal methods that perform the actual tasks. You can control these methods directly. The automatic variable *$ExecutionContext* makes these methods accessible through its *InvokeCommand* property. It is important to know how PowerShell works internally, even though you usually won't need these methods because the special characters are easier to get to.

Special Character	**Definition**	**Internal Method**
"	Resolves variables in a string	*ExpandString()*
&	Executes commands	*InvokeScript()*
{}	Creates a new scriptblock	*NewScriptBlock()*

Table 12.2: Important special characters and the internal methods underlying them

Resolving Variables

Whenever you assign a string in double quotation marks to a variable, PowerShell resolves the variable and replaces it with matching variable contents:

```
$name = 'Tobias Weltner'
# String variables in double quotation marks will be resolved:
$text = "Your name is $name"
$text

  Your name is Tobias Weltner
```

The method *ExpandString()* carries out this resolution internally. This means that variables can also be resolved in the following way:

```
$name = 'Tobias Weltner'
# String variables in single quotation marks will not be resolved:
$text = 'Your name is $name'
$text

  Your name is $name

# The method ExpandString() actually resolves the variable:
$executioncontext.InvokeCommand.ExpandString($text)

  Your name is Tobias Weltner
```

Creating Scriptblocks

If you place PowerShell code in braces, PowerShell will make a scriptblock out of the code. You've seen how you can either use the call operator to immediately execute a scriptblock or to assign it to a function. The method *NewScriptBlock()* is used to generate new scriptblocks:

```
# Create a new scriptblock
$sb = { 4*5 }
$sb.GetType().Name

  ScriptBlock

& $sb

  20

# Do the same using the low level function NewScriptBlock():
$sb = $executioncontext.InvokeCommand.NewScriptBlock('4*5')
$sb.GetType().Name

  ScriptBlock

& $sb

  20
```

Executing Instruction Lines

Input instruction lines are executed internally by the *InvokeScript()* method. The following three commands accomplish the same thing:

```
Invoke-Expression '4*5'
```

```
  20

& { 4*5 }

  20

$executioncontext.InvokeCommand.InvokeScript('4*5')

  20
```

SessionState

SessionState is an object that reflects the current state of your PowerShell environment. You can likewise locate this object in the *$ExecutionContext* automatic variable:

```
$executioncontext.SessionState | Format-List *
Drive      : System.Management.Automation.DriveManagementIntrinsics
Provider   : System.Management.Automation.CmdletProviderManagementIntrinsics
Path       : System.Management.Automation.PathIntrinsics
PSVariable : System.Management.Automation.PSVariableIntrinsics
```

The four properties *Drive*, *Provider*, *Path* and *PSVariable,* are subobjects that you can use to query the current state of these PowerShell areas as well as to modify them.

Managing Variables

PSVariable will retrieve the value of any variable and can also be used to modify variables:

```
$value = "Test"
# Retrieve variable contents:
$executioncontext.SessionState.PSVariable.GetValue("value")
Test
# Modify variable contents:
$executioncontext.SessionState.PSVariable.Set("value", 100)
$value
100
```

Managing Drives

Drive manages drives in PowerShell. You could define the current drive in the following way:

```
$executioncontext.SessionState.Drive.Current

  Name       Provider      Root       CurrentLocation
  ----       --------      ----       ---------------
  C          FileSystem    C:\    Users\Tobias Weltner
```

GetAll() lists all available drives and as such is equivalent to the *Get-PSDrive* cmdlet:

```
$executioncontext.SessionState.Drive.GetAll()

  Name       Provider      Root                      CurrentLocation
  ----       --------      ----                      ---------------
  Alias      Alias
  Env        Environment
  C          FileSystem    C:\                  Users\Tobias Weltner
  D          FileSystem    D:\
  Function   Function
  HKLM       Registry      HKEY_LOCAL_MACHINE
  HKCU       Registry      HKEY_CURRENT_USER
  Variable   Variable
  cert       Certificate   \
```

If you are interested only in the drives of a particular provider, such as only in genuine data file drives, use *GetAllForProvider()* and specify the provider you want:

```
$executioncontext.SessionState.Drive.GetAllForProvider("FileSystem")

  Name       Provider      Root        CurrentLocation
  ----       --------      ----        ---------------
  C          FileSystem    C:\    Users\Tobias Weltner
  D          FileSystem
```

Path Specifications

Path returns several methods that cover all aspects of path names that are usually taken care of by cmdlets (Table 12.3). Moreover, the object offers some additional methods that you can use:

```
# Put together a path name from a directory part and a file part:
$executioncontext.SessionState.Path.Combine("C:", "test.txt")

  C:\test.txt
```

Method	**Description**	**Cmdlet**
CurrentLocation	Current working directory	*Get-Location*
PopLocation()	Retrieve stored directory	*Pop-Location*
PushCurrentLocation()	Store current working directory	*Push-Location*

SetLocation()	Set new directory as current working directory	*Set-Location*
GetResolvedPSPathFromPSPath()	Return absolute path name for specified relative path name	*Resolve-Path*

Table 12.3: Path cmdlets and underlying low-level methods of the SessionState object

Summary

Whenever you assign the task of running a command to PowerShell, it relies on *command discovery* to look up which command is intended. If the command is unclear because several commands have the same name, PowerShell uses a priority list (Table 12.1) and automatically selects a command from it.

You can use the call operator character, "&", to run commands that you do *not* directly input in the console. The call operator carries out the same command discovery process as the console does for direct command inputs. Alternatively, you can use *Get-Command* to carry out command discovery and to pass the result directly to the call operator. This allows you to determine which identically named commands should be executed so that the choice is made by you and not by the integrated PowerShell priority list.

Put everything together in a scriptblock if you would like to invoke more than a single command or to pass arguments to a command. Scriptblocks are nothing more than any piece of PowerShell code enclosed in braces. You can run scriptblocks by using the call operator. It is interesting to note that scriptblocks are the foundation of PowerShell. They provide the basis for many cmdlets and are the "soul" of every function and script.

If you'd like to take a look behind the scenes to see how PowerShell actually does run commands or create scriptblocks, you will need the object in the *$ExecutionContext* automatic variable. It offers you access to many low-level functions, which actually perform the tasks involved when you create scriptblocks or use the call operator (Table 12.2).

CHAPTER 13.

Text and Regular Expressions

PowerShell distinguishes sharply between text in single quotation marks and text in double quotation marks. PowerShell won't modify text wrapped in single quotation marks but it does inspect text in single quotation marks and may modify it by inserting variable contents automatically. Enclosing text in double quotation marks is the foremost and easiest way to couple results and descriptions.

The formatting operator *-f*, one of many specialized string operators, offers more options. For example, you can use *-f* to output text column-by-column and to set it flush. Other string commands are also important. They can replace selected text, change case, and much more.

Pattern recognition adds a layer of complexity because it uses wildcard characters to match patterns. In simple cases, you can use the same wildcards that you use in the file system. Substantially more powerful, but also more complex, are regular expressions.

Topics Covered:

Defining Text

Use quotation marks to delimit it if you'd like to save text in a variable or to output it. Use single quotation marks if you want text to be stored in a variable in (literally) exactly the same way you specified it:

```
$text = 'This text may also contain $env:windir `: $(2+2)'

  This text may also contain $env:windir `: $(2+2)
```

Text will have an entirely different character when you wrap it in (conventional) double quotation marks because enclosed special characters will be evaluated:

```
$text = "This text may also contain $env:windir `: $(2+2)"

  This text may also contain C:\Windows: 4
```

Special Characters in Text

If text is enclosed in double quotation marks, PowerShell will look for particular special characters in it. Two special characters are important in this regard: "$" and the special backtick character, "`".

Resolving Variables

If PowerShell encounters one of the variables from Chapter 3, it will assign the variable its value:

```
$windir = "The Windows directory is here: $env:windir"
$windir

  The Windows directory is here: C:\Windows
```

This also applies to direct variables, which calculate their value themselves:

```
$result = "One CD has the capacity of $(720MB / 1.44MB) diskettes."
$result

  One CD has the capacity of 500 diskettes.
```

Inserting Special Characters

The peculiar backtick character, "`", has two tasks: if you type it before characters that are particularly important for PowerShell, such as "$" or quotation marks, PowerShell will interpret the characters following the backtick as normal text characters. You could output quotation marks in text like this:

```
"This text includes `" quotation marks`""

  This text includes "quotation marks"
```

If one of the letters listed in Table 13.1 follows the backtick character, PowerShell will insert special characters:

```
$text = "This text consists of`ntwo lines."

  This text consists of
  two lines!
```

Escape Sequence	Special Characters
`n	New line
`r	Carriage return
`t	Tabulator
`a	Alarm
`b	Backspace
`'	Single quotation mark

`"	Double quotation mark
`0	Null
``	Backtick character

Table 13.1: Special characters and "escape" sequences for text

"Here-Strings": Acquiring Text of Several Lines

Using "here-strings" is the best way to acquire long text consisting of several lines or many special characters. "Here-strings" are called by this name because they enable you to acquire text exactly the way you want to store it in a text variable, much like a text editor. Here-strings are preceded by the *@"* character and terminated by the *"@* character. Note here once again that PowerShell will automatically resolve (assign variable values and evaluate backtick characters in) text enclosed by *@"* and *"@* characters. If you use single quotation marks instead, the text will remain exactly the way you typed it:

```
$text = @"
Here-Strings can easily stretch over several lines and may also include
"quotation marks". Nevertheless, here, too, variables are replaced with
their values: C:\Windows, and subexpressions like 4 are likewise replaced
with their result. The text will be concluded only if you terminate the
here-string with the termination symbol "@.
"@
$text

  Here-Strings can easily stretch over several lines and may also include
  "quotation marks". Nevertheless, here, too, variables are replaced with
  their values: C:\Windows, and subexpressions like 4 are likewise replaced
  with their result. The text will be concluded only if you terminate the
  here-string with the termination symbol "@.
```

Communicating with the User

If you'd like to request users to input text, use *Read-Host*:

```
$text = Read-Host "Your entry"
Your entry: Hello world!
$text

  Hello world!
```

Text acquired by *Read-Host* behaves like text enclosed in single quotation marks. Consequently, special characters and variables are not resolved. Manually use the *ExpandString()* method if you want to resolve the contents of a text variable later on, that is, have the variables and special characters in it replaced. PowerShell normally uses this method internally when you allocate text in double quotation marks:

```
# Query and output text entry by user:
$text = Read-Host "Your entry"
Your entry: $env:windir
$text

  $env:windir

# Treat entered text as if it were in double quotation marks:
$ExecutionContext.InvokeCommand.ExpandString($text)
$text

  C:\Windows
```

If you'd like to use Read-Host to acquire sensitive data, passwords, use the *-asSecureString* parameter. The screen entries will be masked by asterisks. The result will be a so-called *SecureString*. To be able to work on the encrypted *SecureString* as a normal text entry, it must be changed to plain text first:

```
$pwd = Read-Host -asSecureString "Password"

  Password: *************

$pwd

  System.Security.SecureString

[Runtime.InteropServices.Marshal]::`
PtrToStringAuto([Runtime.InteropServices.Marshal]::`
SecureStringToBSTR($pwd))

  strictly confidential
```

Querying User Name and Password

If you'd like to authenticate a user, such as query his name and password, use *Get-Credential*. This cmdlet uses the secure dialog boxes that are integrated into Windows to request user name and password:

```
Get-Credential -Credential "Your name?"

  UserName        Password
  --------        --------
  \Your name      System.Security.SecureString
```

The result is an object having two properties: the given user name is in *UserName* and the encrypted password is in *Password* as an instance of *SecureString*:

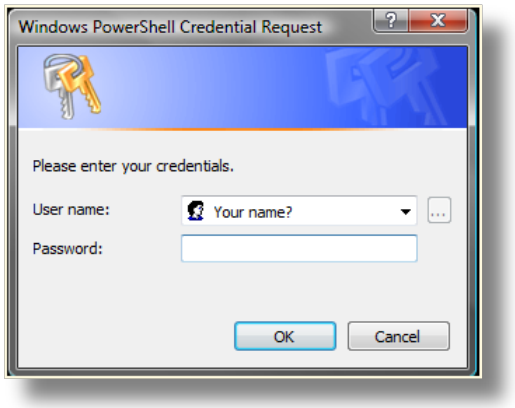

Windows PowerShell Credential Request
Please enter your credentials.
User name:
Your name?
Password:
OK
Cancel

Figure 13.1: Querying user passwords using the integrated secure dialog box

Normally, *Get-Credential* is used if logon data are actually needed, such as to run a program under a particular user name:

```
$logon = Get-Credential
$startinfo = new-object System.Diagnostics.ProcessStartInfo
$startinfo.UserName = $logon.UserName
$startinfo.Password = $logon.Password
$startinfo.FileName = "$env:windir\regedit.exe"
$startinfo.UseShellExecute = $false
[System.Diagnostics.Process]::Start($startinfo)
```

However, the user context that creates the *Secure String* can turn it into readable text whenever you wish, as was the case for *Read-Host*. For this reason, you can also use *Get-Credential* to query sensitive information that you can work on subsequently in plain text:

```
$logon = Get-Credential
[Runtime.InteropServices.Marshal]::`
PtrToStringAuto([Runtime.InteropServices.Marshal]::`
SecureStringToBSTR($logon.Password))

  MySecretPassword
```

Using Special Text Commands

Often, results need to be properly output and provided with descriptions. The simplest approach doesn't require any special commands: insert the result as a variable or sub-expression directly into text and make sure that text is enclosed in double quotation marks.

```
# Embedding a subexpression in text:
"One CD has the capacity of $(720MB / 1.44MB) diskettes."
```

```
  One CD has the capacity of 500 diskettes.

# Embedding a variable in text:
$result = 720MB / 1.44MB
"One CD has the capacity of $result diskettes."

  One CD has the capacity of 500 diskettes.
```

More options are offered by special text commands that PowerShell furnishes from three different areas:

- **String operators:** PowerShell includes a number of string operators for general text tasks, which you can use to replace text and to compare text (Table 13.2).
- **Dynamic methods:** the *String* data type, which saves text, includes its own set of text statements that you can use to search through, dismantle, reassemble, and modify text in diverse ways (Table 13.6).
- **Static methods:**finally, the *String* .NET class includes static methods bound to no particular text.

String Operators

The *-f* format operator is the most important PowerShell string operator. You'll soon be using it to format numeric values for easier reading:

```
"{0} diskettes per CD" -f (720mb/1.44mb)

  500 diskettes per CD
```

All operators function in basically the same way: they anticipate data from the left and the right that they can link together. For example, you can use *-replace* to substitute parts of the string for other parts:

```
"Hello Carl" -replace "Carl", "Eddie"

  Hello Eddie
```

There are three implementations of the *-replace* operator; many other string operators also have three implementations. Its basic version is case insensitive. If you'd like to distinguish between lowercase and uppercase, use the version beginning with "c" (for *case-sensitive*):

```
# No replacement because case sensitivity was turned off this time:
"Hello Carl" -creplace "carl", "eddie"

  Hello Carl
```

The third type begins with "i" (for *insensitive*) and is case insensitive. This means that this version is actually superfluous because it works the same way as *-replace*. The third version is merely demonstrative: if you use *-ireplace* instead of *-replace*, you'll make clear that you expressly do *not* want to distinguish between uppercase and lowercase.

Operator	**Description**	**Example**
*	Repeats a string	*"=" * 20*
+	Combines two string parts	*"Hello " + "World"*
-replace, -ireplace	Substitutes a string; case insensitive	*"Hello Carl" -replace "Carl", "Eddie"*
-creplace	Substitutes a string; case sensitive	*"Hello Carl" -creplace "carl", "eddie"*
-eq, -ieq	Verifies equality; case insensitive	*"Carl" -eq "carl"*
-ceq	Verifies equality; case sensitive	*"Carl" -ceq "carl"*
-like, -ilike	Verifies whether a string is included in another string (wildcards are permitted; case insensitive)	*"Carl" -like "*AR*"*
-clike	Verifies whether a string is included in another string (wildcards are permitted; case sensitive)	*"Carl" -clike "*AR*"*
-notlike, -inotlike	Verifies whether a string is not included in another string (wildcards are permitted; case insensitive)	*"Carl" -notlike "*AR*"*
-cnotlike	Verifies whether a string is included in another string (wildcards are permitted; case sensitive)	*"Carl" -cnotlike "*AR*"*
-match, -imatch	Verifies whether a pattern is in a string; case insensitive	*"Hello" -match "[ao]"*
-cmatch	Verifies whether a pattern is in a string; case sensitive	*"Hello" -cmatch "[ao]"*

-notmatch, -inotmatch	Verifies whether a pattern is not in a string; case insensitive	*"Hello" -notmatch "[ao]"*
-cnotmatch	Verifies whether a pattern is not in a string; case sensitive	*"Hello" -cnotmatch "[ao]"*

Table 13.2: Operators used for handling string

Formatting String

The format operator *-f* formats a string and requires a string, along with wildcards on its left side and on its right side, that the results are to be inserted into the string instead of the wildcards:

```
"{0} diskettes per CD" -f (720mb/1.44mb)

  500 diskettes per CD
```

It is absolutely necessary that exactly the same results are on the right side that are to be used in the string are also on the left side. If you want to just calculate a result, then the calculation should be in parentheses. As is generally true in PowerShell, the parentheses ensure that the enclosed statement is evaluated first and separately and that subsequently, the result is processed instead of the parentheses. Without parentheses, *-f* would report an error:

```
"{0} diskettes per CD" -f 720mb/1.44mb

  Bad numeric constant: 754974720 diskettes per CD.
  At line:1 char:33
  + "{0} diskettes per CD" -f 720mb/1 <<<< .44mb
```

You may use as many wildcard characters as you wish. The number in the braces states which value will appear later in the wildcard and in which order:

```
"{0} {3} at {2}MB fit into one CD at {1}MB" `
-f (720mb/1.44mb), 720, 1.44, "diskettes"

  500 diskettes at 1.44MB fit into one CD at 720MB
```

Setting Numeric Formats

The formatting operator *-f* can insert values into text as well as format the values. Every wildcard used has the following formal structure: *{index[,alignment][:format]}*:

- **Index:** This number indicates which value is to be used for this wildcard. For example, you could use several wildcards with the same index if you want to output one and the same value several times, or in various display formats. The index number is the only obligatory specification. The other two specifications are voluntary.
- **Alignment:** Positive or negative numbers can be specified that determine whether the value is right justified (positive number) or left justified (negative number). The number states the desired width. If the value is wider than the specified width, the specified width will be ignored. However, if the value is narrower than the specified width, the width will be filled with blank characters. This allows columns to be set flush.
- **Format:** The value can be formatted in very different ways. Here you can use the relevant format name to specify the format you wish. You'll find an overview of available formats below.

note

Formatting statements are case sensitive in different ways than what is usual in PowerShell. You can see how large the differences can be when you format dates:

```
# Formatting with a small letter d:
"Date: {0:d}" -f (Get-Date)

  Date: 08/28/2007

# Formatting with a large letter D:
"Date: {0:D}" -f (Get-Date)

  Date: Tuesday, August 28, 2007
```

Symbol	Type	Call	Result
#	Digit placeholder	"{0:(#).##}" -f $value	(1000000)
%	Percentage	"{0:0%}" -f $value	100000000%
,	Thousands separator	"{0:0,0}" -f $value	1,000,000
,.	Integral multiple of 1,000	"{0:0,.} " -f $value	1000
.	Decimal point	"{0:0.0}" -f $value	1000000.0
0	0 placeholder	"{0:00.0000}" -f $value	1000000.0000

c	Currency	"{0:c}" -f $value	1,000,000.00 â,¬
d	Decimal	"{0:d}" -f $value	1000000
e	Scientific notation	"{0:e}" -f $value	1.000000e+006
e	Exponent wildcard	"{0:00e+0}" -f $value	10e+5
f	Fixed point	"{0:f}" -f $value	1000000.00
g	General	"{0:g}" -f $value	1000000
n	Thousands separator	"{0:n}" -f $value	1,000,000.00
x	Hexadecimal	"0x{0:x4}" -f $value	0x4240

Table 13.3: Formatting numbers

Using the formats in Table 13.3, you can format numbers quickly and comfortably. No need for you to squint your eyes any longer trying to decipher whether a number is a million or 10 million:

```
10000000000
"{0:N0}" -f 10000000000
10,000,000,000
```

There's also a very wide range of time and date formats. The relevant formats are listed in Table 13.4 and their operation is shown in the following lines:

```
$date= Get-Date
Foreach ($format in "d","D","f","F","g","G","m","r","s","t","T", `
  "u","U","y","dddd, MMMM dd yyyy","M/yy","dd-MM-yy") {
    "DATE with $format : {0}" -f $date.ToString($format) }

  DATE with d : 10/15/2007
  DATE with D : Monday, 15 October, 2007
  DATE with f : Monday, 15 October, 2007 02:17 PM
  DATE with F : Monday, 15 October, 2007 02:17:02 PM
  DATE with g : 10/15/2007 02:17
  DATE with G : 10/15/2007 02:17:02
  DATE with m : October 15
  DATE with r : Mon, 15 Oct 2007 02:17:02 GMT
  DATE with s : 2007-10-15T02:17:02
  DATE with t : 02:17 PM
  DATE with T : 02:17:02 PM
  DATE with u : 2007-10-15 02:17:02Z
  DATE with U : Monday, 15 October, 2007 00:17:02
  DATE with y : October, 2007
  DATE with dddd, MMMM dd yyyy : Monday, October 15 2007
  DATE with M/yy : 10/07
  DATE with dd-MM-yy : 15-10-07
```

Symbol	**Type**	**Call**	**Result**
d	Short date format	"{0:d}" -f $value	09/07/2007
D	Long date format	"{0:D}" -f $value	Friday, September 7, 2007
t	Short time format	"{0:t}" -f $value	10:53 AM
T	Long time format	"{0:T}" -f $value	10:53:56 AM
f	Full date and time (short)	"{0:f}" -f $value	Friday, September 7, 2007 10:53 AM
F	Full date and time (long)	"{0:F}" -f $value	Friday, September 7, 2007 10:53:56 AM
g	Standard date (short)	"{0:g}" -f $value	09/07/2007 10:53 AM
G	Standard date (long)	"{0:G}" -f $value	09/07/2007 10:53:56 AM
M	Day of month	"{0:M}" -f $value	September 07
r	RFC1123 date format	"{0:r}" -f $value	Fri, 07 Sep 2007 10:53:56 GMT
s	Sortable date format	"{0:s}" -f $value	2007-09-07T10:53:56

u	Universally sortable date format	"{0:u}" -f $value	2007-09-07 10:53:56Z
U	Universally sortable GMT date format	"{0:U}" -f $value	Friday, September 7, 2007 08:53:56
Y	Year/month format pattern	"{0:Y}" -f $value	September 2007

Table 13.4: Formatting date values

If you want to find out which type of formatting options are supported, you need only look for .NET types that support the *toString()* method:

```
[appdomain]::currentdomain.getassemblies() | ForEach-Object {
  $_.GetExportedTypes() | Where-Object {! $_.IsSubclassof([System.Enum])}
} | ForEach-Object {
  $Methods = $_.getmethods() | Where-Object {$_.name -eq "tostring"} |%{"$_"};
  If ($methods -eq "System.String ToString(System.String)") {
    $_.fullname
  }
}

   System.Enum
   System.DateTime
   System.Byte
   System.Convert
   System.Decimal
   System.Double
   System.Guid
   System.Int16
   System.Int32
   System.Int64
   System.IntPtr
   System.SByte
   System.Single
   System.UInt16
   System.UInt32
   System.UInt64
   Microsoft.PowerShell.Commands.MatchInfo
```

For example, among the supported data types is the "globally unique identifier" *System.Guid*. Because you'll frequently require GUID, which is clearly understood worldwide, here's a brief example showing how to create and format a GUID:

```
$guid = [GUID]::NewGUID()
Foreach ($format in "N","D","B","P") {
  "GUID with $format : {0}" -f $GUID.ToString($format)}
```

```
GUID with N : 0c4d2c4c8af84d198b698e57c1aee780
GUID with D : 0c4d2c4c-8af8-4d19-8b69-8e57c1aee780
GUID with B : {0c4d2c4c-8af8-4d19-8b69-8e57c1aee780}
GUID with P : (0c4d2c4c-8af8-4d19-8b69-8e57c1aee780)
```

Symbol	**Type**	**Call**	**Result**
dd	Day of month	"{0:dd}" -f $value	07
ddd	Abbreviated name of day	"{0:ddd}" -f $value	Fri
dddd	Full name of day	"{0:dddd}" -f $value	Friday
gg	Era	"{0:gg}" -f $value	A. D.
hh	Hours from 01 to 12	"{0:hh}" -f $value	10
HH	Hours from 0 to 23	"{0:HH}" -f $value	10
mm	Minute	"{0:mm}" -f $value	53
MM	Month	"{0:MM}" -f $value	09
MMM	Abbreviated month name	"{0:MMM}" -f $value	Sep
MMMM	Full month name	"{0:MMMM}" -f $value	September
ss	Second	"{0:ss}" -f $value	56
tt	AM or PM	"{0:tt}" -f $value	
yy	Year in two digits	"{0:yy}" -f $value	07
yyyy	Year in four digits	"{0:YY}" -f $value	2007
zz	Time zone including leading zero	"{0:zz}" -f $value	+02
zzz	Time zone in hours and minutes	"{0:zzz}" -f $value	+02:00

Table 13.5: Customized date value formats

Outputting Values in Tabular Form: Fixed Width

To display the output of several lines in a fixed-width font and align them one below the other, each column of the output must have a fixed width. A formatting operator can set outputs to a fixed width.

In the following example, *Dir* returns a directory listing, from which a subsequent loop outputs file names and file sizes. Because file names and sizes vary, the result is ragged right and hard to read:

```
dir | ForEach-Object { "$($_.name) = $($_.Length) Bytes" }

  history.csv = 307 Bytes
  info.txt = 8562 Bytes
  layout.lxy = 1280 Bytes
  list.txt = 164186 Bytes
  p1.nrproj = 5808 Bytes
  ping.bat = 116 Bytes
  SilentlyContinue = 0 Bytes
```

The following result with fixed column widths is far more legible. To set widths, add a comma to the sequential number of the wildcard and after it specify the number of characters available to the wildcard. Positive numbers will set values to right alignment, negative numbers to left alignment:

```
dir | ForEach-Object { "{0,-20} = {1,10} Bytes" -f $_.name, $_.Length }

  history.csv          =        307 Bytes
  info.txt             =       8562 Bytes
  layout.lxy           =       1280 Bytes
  list.txt             =     164186 Bytes
  p1.nrproj            =       5808 Bytes
  ping.bat             =        116 Bytes
  SilentlyContinue     =          0 Bytes
```

String Object Methods

You know from Chapter 6 that PowerShell stores everything in objects and that every object contains a set of instructions known as methods. Text is stored in a *String object,* which includes a number of useful commands for working with text. For example, to ascertain the file extension of a file name, use *LastIndexOf()* to determine the position of the last "." character, and then use *Substring()* to extract text starting from the position:

```
$path = "c:\test\Example.bat"
```

```
$path.Substring( $path.LastIndexOf(".")+1 )

  bat
```

Another approach uses the dot as separator and *Split()* to split up the path into an array. The result is that the last element of the array (-1 index number) will include the file extension:

```
$path.Split(".")[-1]

  bat
```

Table 13.6 provides an overview of all the methods that include a string object.

Function	**Description**	**Example**
CompareTo()	Compares one string to another	("Hello").CompareTo("Hello")
Contains()	Returns "True" if a specified comparison string is in a string or if the comparison string is empty	("Hello").Contains("ll")
CopyTo()	Copies part of a string to another string	$a = ("Hello World").toCharArray() ("User!").CopyTo(0, $a, 6, 5) $a
EndsWith()	Tests whether the string ends with a specified string	("Hello").EndsWith("lo ")
Equals()	Tests whether one string is identical to another string	("Hello").Equals($a)
IndexOf()	Returns the index of the first occurrence of a comparison string	("Hello").IndexOf("l")
IndexOfAny()	Returns the index of the first occurrence of any character in a comparison string	("Hello").IndexOfAny("loe")
Insert()	Inserts new string at a specified index in an existing string	("Hello World").Insert(6, "brave ")

GetEnumerator()	Retrieves a new object that can enumerate all characters of a string	("Hello").GetEnumerator()
LastIndexOf()	Finds the index of the last occurrence of a specified character	("Hello").LastIndexOf("l")
LastIndexOfAny()	Finds the index of the last occurrence of any character of a specified string	("Hello").LastIndexOfAny("loe")
PadLeft()	Pads a string to a specified length and adds blank characters to the left (right-aligned string)	("Hello").PadLeft(10)
PadRight()	Pads string to a specified length and adds blank characters to the right (left-aligned string)	("Hello").PadRight(10) + "World!"
Remove()	Removes any requested number of characters starting from a specified position	("Hello World").Remove(5,6)
Replace()	Replaces a character with another character	("Hello World").Replace("l", "x")
Split()	Converts a string with specified splitting points into an array	("Hello World").Split("l")
StartsWith()	Tests whether a string begins with a specified character	("Hello World").StartsWith("He")
Substring()	Extracts characters from a string	("Hello World").Substring(4, 3)
ToCharArray()	Converts a string into a character array	("Hello World").toCharArray()
ToLower()	Converts a string to lowercase	("Hello World").toLower()

ToLowerInvariant()	Converts a string to lowercase using casing rules of the invariant language	("Hello World").toLowerInvariant()
ToUpper()	Converts a string to uppercase	("Hello World").toUpper()
ToUpperInvariant()	Converts a string to uppercase using casing rules of the invariant language	("Hello World").ToUpperInvariant()
Trim()	Removes blank characters to the right and left	(" Hello ").Trim() + "World"
TrimEnd()	Removes blank characters to the right	(" Hello ").TrimEnd() + "World"
TrimStart()	Removes blank characters to the left	(" Hello ").TrimStart() + "World"
Chars()	Provides a character at the specified position	("Hello").Chars(0)

Table 13.6: The methods of a string object

Analyzing Methods: Split() as Example

You already know in detail from Chapter 6 how to use *Get-Member* to find out which methods an object contains and how to invoke them. Just as a quick refresher, let's look again at an example of the *Split()* method to see how it works.

```
("something" | Get-Member Split).definition

  System.String[] Split(Params Char[] separator), System.String[] Split(
  Char[] separator, Int32 count), System.String[] Split(Char[] separator,
  StringSplitOptions options), System.String[] Split(Char[] separator,
  Int32 count, StringSplitOptions options), System.String[] Split(String[]
  separator, StringSplitOptions options), System.String[] Split(String[]
  separator, Int32 count, StringSplitOptions options)
```

Definition gets output, but it isn't very easy to read. Because *Definition* is also a string object, you can use methods from Table 13.6, including *Replace()*, to insert a line break where appropriate. That makes the result much more understandable:

```
("something" | Get-Member Split).Definition.Replace("), ", ")`n")

  System.String[] Split(Params Char[] separator)
  System.String[] Split(Char[] separator, Int32 count)
  System.String[] Split(Char[] separator, StringSplitOptions options)
  System.String[] Split(Char[] separator, Int32 count,
    StringSplitOptions options)
  System.String[] Split(String[] separator, StringSplitOptions options)
  System.String[] Split(String[] separator, Int32 count,
    StringSplitOptions options)
```

There are six different ways to invoke *Split()*. In simple cases, you might use *Split()* with only one argument, *Split()*, you will expect a character array and will use every single character as a possible splitting separator. That's important because it means that you may use several separators at once:

```
"a,b;c,d;e;f".Split(",;")

  a
  b
  c
  d
  e
  f
```

If the splitting separator itself consists of several characters, then it has got to be a string and not a single *Char* character. There are only two signatures that meet this condition:

```
  System.String[] Split(String[] separator,
    StringSplitOptions options)
  System.String[] Split(String[] separator, Int32 count,
    StringSplitOptions options)
```

You must make sure that you pass data types to the signature that is exactly right for it to be able to use a particular signature. If you want to use the first signature, the first argument must be of the *String[]* type and the second argument of the *StringSplitOptions* type. The simplest way for you to meet this requirement is by assigning arguments first to a strongly typed variable. Create the variable with exactly the type that the signature requires:

```
# Create a variable of the [StringSplitOptions] type:
[StringSplitOptions]$option = "None"
# Create a variable of the String[] type:
[string[]]$separator = ",;"
# Invoke Split with the wished signature and use a two-character long separator:
("a,b;c,;d,e;f,;g").Split($separator, $option)

  a,b;c
  d,e;f
  g
```

Split() in fact now uses a separator consisting of several characters. It splits the string only at the points where it finds precisely the characters that were specified. There does remain the question of how do you know it is necessary to assign the value "*None*" to the *StringSplitOptions* data type. The simple answer is: you don't know and it isn't necessary to know. If you assign a value to an unknown data type that can't handle the value, the data type will automatically notify you of all valid values:

```
[StringSplitOptions]$option = "werner wallbach"

  Cannot convert value "werner wallbach" to type
  "System.StringSplitOptions" due to invalid enumeration
  values. Specify one of the following enumeration values
  and try again. The possible enumeration values are
  "None, RemoveEmptyEntries".
  At line:1 char:28
  + [StringSplitOptions]$option  <<<< = "werner wallbach"
```

By now it should be clear to you what the purpose is of the given valid values and their names. For example, what was *RemoveEmptyEntries()* able to accomplish? If *Split()* runs into several separators following each other, empty array elements will be the consequence. *RemoveEmptyEntries()* deletes such empty entries. You could use it to remove redundant blank characters from a text:

```
[StringSplitOptions]$option = "RemoveEmptyEntries"
"This   text   has   too   much   whitespace".Split(" ", $option)

  This
  text
  has
  too
  much
  whitespace
```

Now all you need is just a method that can convert the elements of an array back into text. The method is called *Join()*; it is not in a *String* object but in the *String* class.

Using String Class Commands

Chapter 6 clearly defined the distinction between classes and objects (or instances). Just to refresh your memory: every *String* object is derived from the *String* class. Both include diverse methods. You can see these methods at work when you press (Tab) after the following instruction, which activates AutoComplete:

```
[String]::(Tab)
```

Get-Member will return a list of all methods. This time, specify the *-Static* parameter in addition:

```
"sometext" | Get-Member -Static -MemberType Method
```

You've already used static methods. In reality, the *-f* format operator corresponds to the *Format()* static method, and that's why the following two statements work in exactly the same way:

```
# Using a format operator:
"Hex value of 180 is &h{0:X}" -f 180
```

```
    Hex value of 180 is &hB4

  # The static method Format has the same result:
  [string]::Format("Hex value of 180 is &h{0:X}", 180)

    Hex value of 180 is &hB4
```

The *Format()* static method is very important but is usually ignored because *-f* is much easier to handle. But you wouldn't be able to do without two other static methods: *Join()* and *Concat()*.

Join(): Changing Arrays to Text

Join() is the counterpart of *Split()* discussed above. *Join()* assembles an array of string elements into a string. It enables you to complete the above example and to make a function that removes superfluous white space characters from the string:

```
  function RemoveSpace([string]$text) {
    $private:array = $text.Split(" ", `
      [StringSplitOptions]::RemoveEmptyEntries)
    [string]::Join(" ", $array)
  }
  RemoveSpace "Hello,   this   text   has   too   much   whitespace."

    Hello, this text has too much whitespace.
```

Concat(): Assembling a String Out of Several Parts

Concat() assembles a string out of several separate parts. At first glance, it works like the "+" operator:

```
  "Hello" + " " + "World!"

    Hello World!
```

But note that the "+" operator always acts strangely when the first value isn't a string:

```
  # Everything will be fine if the first value is string:
  "Today is " + (Get-Date)

    Today is 08/29/2007 11:02:24

  # If the first value is not text, errors may result:
  (Get-Date) + " is a great date!"

    Cannot convert argument "1", with value: " is a great date!",
    for "op_Addition" to type "System.TimeSpan": "Cannot convert
    value " is a great date!" to type "System.TimeSpan". Error:
    "Input string was not in a correct format.""
    At line:1 char:13
    + (Get-Date) +  <<<< " is a great date!
```

If the first value of the calculation is a string, all other values will be put into the string form and assembled as requested into a complete string. If the first value is not a string—in the example, it was a date value—all the other values will be changed to this type. That's just what causes an error, because it is impossible to change *"is a great date!"* to a date value. For this reason, the "+" operator is an unreliable tool for assembling a string.

Concat() causes fewer problems: it turns everything you specify to the method into a string. *Concat()*, when converting, also takes into account your current regional settings; it will provide, for example, U.S. English date and time formats:

```
  [string]::Concat("Today is ", (Get-Date))

    Today is 8/29/2007 11:06:00 AM

  [string]::Concat((Get-Date), " is a great date!")

    8/29/2007 11:06:24 AM is a great date!
```

Simple Pattern Recognition

Recognizing patterns is a frequent task that is necessary for verifying user entries, such as to determine whether a user has given a valid network ID or valid e-mail address. Useful and effective pattern recognition requires wildcard characters that represent a certain number and type of characters.

A simple form of wildcards was invented for the file system many years ago and it still works today. In fact, you've doubtlessly used it before in one form or another:

```
# List all files in the current directory that
# have the txt file extension:
Dir *.txt
# List all files in the Windows directory that
# begin with "n" or "w":
dir $env:windir\[nw]*.*
# List all files whose file extensions begin with
# "t" and which are exactly 3 characters long:
Dir *.t??
# List all files that end in one of the letters
# from "e" to "z"
dir *[e-z].*
```

Wildcard	Description	Example
*	Any number of any character (including no characters	*Dir *.txt*

	at all)	
?	Exactly one of any characters	*Dir *.??t*
[xyz]	One of specified characters	*Dir [abc]*.**
[x-z]	One of the characters in the specified area	*Dir *[p-z].**

Table 13.7: Using simple placeholders

The placeholders in Table 13.7 not only work in the file system, but also in conjunction with string operators like *-like* and *-notlike*. This makes child's play of pattern recognition. For example, if you want to verify whether a user has given a valid IP address, you could do so in the following way:

```
$ip = Read-Host "IP address"
If ($ip -like "*.*.*.*") { "valid" } Else { "invalid" }
```

If you want to verify whether a valid e-mail address is in a variable, you could check the pattern in the following way:

```
$email = "tobias.weltner@powershell.de"
$email -like "*.*@*.*"
```

However, such wildcards only reveal the worst errors and are not very exact:

```
# Wildcards are appropriate only for very simple pattern
# recognition and leave room for erroneous entries:
$ip = "300.werner.6666."
If ($ip -like "*.*.*.*") { "valid" } Else { "invalid" }

  valid

# The following invalid e-mail address was not identified as false:
$email = ".@."
$email -like "*.*@*.*"

  True
```

Regular Expressions

Use regular expressions for more accurate pattern recognition if you require it. Regular expressions offer many more wildcard characters; for this reason, they can describe patterns in much greater detail. For the very same reason, however, regular expressions are also much more complicated.

Describing Patterns

Using the regular expression elements listed in Table 13.11, you can describe patterns with much greater precision. These elements are grouped into three categories:

- **Char:** The *Char* represents a single character and a collection of *Char* objects represents a string.
- **Quantifier:** Allows you to determine how often a character or a string occurs in a pattern.
- **Anchor:** Allows you to determine whether a pattern is a separate word or must be at the beginning or end of a sentence.

The pattern represented by a regular expression may consist of four different character types:

- **Literal characters**like "abc" that exactly matches the "abc" string.
- **Masked or "escaped" characters** with special meanings in regular expressions; when preceded by "\", they are understood as literal characters: "\[test\]" looks for the "[test]" string. The following characters have special meanings and for this reason must be masked if used literally: ". ^ $ * + ? { [ ] \ | ( )".
- **Predefined wildcard characters**that represent a particular character category and work like placeholders. For example, "\d" represents any number from 0 to 9.
- **Custom wildcard characters:** They consist of square brackets, within which the characters are specified that the wildcard represents. If you want to use any character *except for* the specified characters, use "^" as the first character in the square brackets. For example, the placeholder "[^f-h]" stands for all characters except for "f", "g", and "h".

Element	**Description**
.	Exactly one character of any kind except for a line break (equivalent to [^\n])
[^abc]	All characters except for those specified in brackets
[^a-z]	All characters except for those in the range specified in the brackets
[abc]	One of the characters specified in brackets
[a-z]	Any character in the range indicated in brackets
\a	Bell alarm (ASCII 7)
\c	Any character allowed in an XML name
\cA-\cZ	Control+A to Control+Z, equivalent to ASCII 0 to ASCII 26

\d	A number (equivalent to [0-9])
\D	Any character except for numbers
\e	Escape (ASCII 9)
\f	Form feed (ASCII 15)
\n	New line
\r	Carriage return
\s	Any whitespace character like a blank character, tab, or line break
\S	Any character except for a blank character, tab, or line break
\t	Tab character
\u*FFFF*	Unicode character with the hexadecimal code FFFF. For example, the Euro symbol has the code 20AC
\v	Vertical tab (ASCII 11)
\w	Letter, digit, or underline
\W	Any character except for letters
\x*nn*	Particular character, where nn specifies the hexadecimal ASCII code
.*	Any number of any character (including no characters at all)

Table 13.8: Placeholders for characters

Quantifiers

Every wildcard listed in Table 13.8 is represented by exactly one character. Using quantifiers, you can more precisely determine how many characters are respectively represented. For example, "\d{1,3}" stands for a number occurring one to three times for a one-to-three digit number.

Element	**Description**
*	Preceding expression is not matched or matched once or several times (matches as much as possible)
*?	Preceding expression is not matched or matched once or several times (matches as little as possible)
.*	Any number of any character (including no characters at all)
?	Preceding expression is not matched or matched once (matches as much as possible)
??	Preceding expression is not matched or matched once (matches as little as possible)
{n,}	n or more matches
{n,m}	Inclusive matches between n and m
{n}	Exactly n matches
+	Preceding expression is matched once

Table 13.9: Quantifiers for patterns

Anchors

Anchors determine whether a pattern has to be at the beginning or ending of a string. For example, the regular expression "\b\d{1,3}" finds numbers only up to three digits if these turn up separately in a string. The number "123" in the string "Bart123" would not be found.

Elements	**Description**

$	Matches at end of a string (\Z is less ambiguous for multi-line texts)
\A	Matches at beginning of a string, including multi-line texts
\b	Matches on word boundary (first or last characters in words)
\B	Must not match on word boundary
\Z	Must match at end of string, including multi-line texts
^	Must match at beginning of a string (\A is less ambiguous for multi-line texts)

Table 13.10: Anchor boundaries

Recognizing IP Addresses

The patterns, such as an IP address, can be much more precisely described by regular expressions than by simple wildcard characters. Usually, you would use a combination of characters and quantifiers to specify which characters may occur in a string and how often:

```
$ip = "10.10.10.10"
$ip -match "\b\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\b"

  True

$ip = "a.10.10.10"
$ip -match "\b\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\b"

  False

$ip = "1000.10.10.10"
$ip -match "\b\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\b"

  False
```

The pattern is described here as four numbers (char: *d*) between one and three digits (using the quantifier *{1,3}*) and anchored on word boundaries (using the anchor *b*), meaning that it is surrounded by white space like blank characters, tabs, or line breaks. Checking is far from perfect since it is not verified whether the numbers really do lie in the permitted number range from 0 to 255.

```
# There still are entries incorrectly identified as valid IP addresses:
```

```
$ip = "300.400.500.999"
$ip -match "\b\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\b"

  True
```

Validating E-Mail Addresses

If you'd like to verify whether a user has given a valid e-mail address, use the following regular expression:

```
$email = "test@somewhere.com"
$email -match "\b[A-Z0-9._%+-]+@[A-Z0-9.-]+\.[A-Z]{2,4}\b"

  True

$email = ".@."
$email -match "\b[A-Z0-9._%+-]+@[A-Z0-9.-]+\.[A-Z]{2,4}\b"

  False
```

Whenever you look for an expression that occurs as a single "word" in text, delimit your regular expression by word boundaries (anchor: \b). The regular expression will then know you're interested only in those passages that are demarcated from the rest of the text by white space like blank characters, tabs, or line breaks.

The regular expression subsequently specifies which characters may be included in an e-mail address. Permissible characters are in square brackets and consist of "ranges" (for example, "A-Z0-9") and single characters (such as "._%+-"). The "+" behind the square brackets is a quantifier and means that at least one of the given characters must be present. However, you can also stipulate as many more characters as you wish.

Following this is "@" and, if you like, after it a text again having the same characters as those in front of "@". A dot (\.) in the e-mail address follows. This dot is introduced with a "\" character because the dot actually has a different meaning in regular expressions if it isn't within square brackets. The backslash ensures that the regular expression understands the dot behind it literally.

After the dot is the domain identifier, which may consist solely of letters (*[A-Z]*). A quantifier (*{2,4}*) again follows the square brackets. It specifies that the domain identifier may consist of at least two and at most four of the given characters.

However, this regular expression still has one flaw. While it does verify whether a valid e-mail address is in the text somewhere, there could be another text before or after it:

```
$email = "Email please to test@somewhere.com and reply!"
$email -match "\b[A-Z0-9._%+-]+@[A-Z0-9.-]+\.[A-Z]{2,4}\b"

  True
```

Because of "\b", when your regular expression searches for a pattern somewhere in the text, it only takes into account word boundaries. If you prefer to check whether the entire text corresponds to an authentic e-mail, use the elements for sentence beginnings (anchor: "^") and endings (anchor: "$"):instead of word boundaries.

```
$email -match "^[A-Z0-9._%+-]+@[A-Z0-9.-]+\.[A-Z]{2,4}$"
```

Simultaneous Searches for Different Terms

Sometimes, search terms are ambiguous because there may be several ways to write them. You can use the "?" quantifier to mark parts of the search term as optional. In simple cases, put a "?" after an optional character. Then the character in front of "?" may, but doesn't have to, turn up in the search term:

```
"color" -match "colou?r"
True
"colour" -match "colou?r"
True
```

important

The "?" character here doesn't represent any character at all, as you might expect after using simple wildcards. For regular expressions, "?" is a quantifier and always specifies how often a character or expression in front of it may occur. In the example, therefore, "u?" ensures that the letter "u" may, but not necessarily, be in the specified location in the pattern. Other quantifiers are "*" (may also match more than one character) and "+" (must match characters at least once).

If you prefer to mark more than one character as optional, put the character in a sub-expression, which are placed in parentheses. The following example recognizes both the month designator "Nov" and "November":

```
"Nov" -match "\bNov(ember)?\b"

  True

"November" -match "\bNov(ember)?\b"

  True
```

If you'd rather use several alternative search terms, use the OR character "|":

```
"Bob and Ted" -match "Alice|Bob"

  True
```

And if you want to mix alternative search terms with fixed text, use sub-expressions again:

```
# finds "and Bob":
"Peter and Bob" -match "and (Bob|Willy)"

  True

# does not find "and Bob":
"Bob and Peter" -match "and (Bob|Willy)"

  False
```

Case Sensitivity

In keeping with customary PowerShell practice, the *-match* operator is case insensitive. Use the operator *-cmatch* as alternative if you'd prefer case sensitivity.:

```
# -match is case insensitive:
"hello" -match "heLLO"

  True

# -cmatch is case sensitive:
"hello" -cmatch "heLLO"

  False
```

If you want case sensitivity in only some pattern segments, use *-match*. Also, specify in your regular expression which text segments are case sensitive and which are insensitive. Anything following the "(?i)" construct is case insensitive. Conversely, anything following "(?-i)" is case sensitive. This explains why the word "test" in the below example is recognized only if its last two characters are lowercase, while case sensitivity has no importance for the first two characters:

```
"TEst" -match "(?i)te(?-i)st"

  True

"TEST" -match "(?i)te(?-i)st"

  False
```

If you use a .NET framework *RegEx* object instead of *-match*, the *RegEx* object will automatically sense shifts between uppercase and lowercase, behaving like *-cmatch*. If you prefer case insensitivity, either use the above construct to specify an option in your regular expression or avail yourself of "*IgnoreCase*" to tell the *RegEx* object your preference:

```
 [regex]::matches("test", "TEST", "IgnoreCase")
```

Element	Description	Category
(xyz)	Sub-expression	
|	Alternation construct	Selection
\	When followed by a character, the character is not recognized as a formatting character but as a literal character	Escape
x?	Changes the x quantifier into a "lazy" quantifier	Option
(?xyz)	Activates of deactivates special modes, among others, case sensitivity	Option
x+	Turns the x quantifier into a "greedy" quantifier	Option
?:	Does not backtrack	Reference
?<*name*>	Specifies name for back references	Reference

Table 13.11: Regular expression elements

note Of course, a regular expression can perform any number of detailed checks, such as verifying whether numbers in an IP address lie within the permissible range from 0 to 255. The problem is that this makes regular expressions long and hard to understand. Fortunately, you generally won't need to invest much time in learning complex regular expressions like the ones coming up. It's enough to know which regular expression to use for a particular pattern. Regular expressions for nearly all standard patterns can be downloaded from the Internet. In the following example, we'll look more closely at a complex regular expression that evidently is entirely made up of the conventional elements listed in Table 13.11:

```
$ip = "300.400.500.999"
$ip -match "\b(?:(?:25[0-5]|2[0-4][0-9]|[01]?[0-9][0-9]?)\.)" +
`
  "{3}(?:25[0-5]|2[0-4][0-9]|[01]?[0-9][0-9]?)\b"
```

```
    False
```

The expression validates only expressions running into word boundaries (the anchor is \b). The following sub-expression defines every single number:

```
   (?:25[0-5]|2[0-4][0-9]|[01]?[0-9][0-9]?)
```

The construct *?:* is optional and enhances speed. After it come three alternatively permitted number formats separated by the alternation construct "|". *25[0-5]* is a number from *250* through *255*. *2[0-4][0-9]* is a number from *200* through *249*. Finally, *[01]?[0-9][0-9]?* is a number from *0-9* or *00-99* or *100-199.* The quantifier "?" ensures that the preceding pattern must be included. The result is that the sub-expression describes numbers from 0 through 255. An IP address consists of four such numbers. A dot always follows the first three numbers. For this reason, the following expression includes a definition of the number:

```
  (?:(?:25[0-5]|2[0-4][0-9]|[01]?[0-9][0-9]?)\.){3}
```

A dot, (\.), is appended to the number. This construct is supposed to be present three times (*{3}*). When the fourth number is also appended, the regular expression is complete. You have learned to create sub-expressions (by using parentheses) and how to iterate sub-expressions (by indicating the number of iterations in braces after the sub-expression), so you should now be able to shorten the first used IP address regular expression:

```
  $ip = "10.10.10.10"
  $ip -match "\b\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\b"

    True

  $ip -match "\b(?:\d{1,3}\.){3}\d{1,3}\b"

    True
```

Finding Information in Text

Regular expressions can recognize patterns. They can also filter out data corresponding to certain patterns from text. As such, regular expressions are excellent tools for parsing raw data. For example, use the same regular expression as the one above to identify e-mail addresses if you want to extract an e-mail address from a letter. Afterwards, look in the *$matches* variable to see which results were returned. The *$matches* variable is created automatically when you use the *-match* operator (or one of its siblings, like *-cmatch*).

$matches is a hash table (Chapter 4), so you can either output the entire hash table or access single elements in it by using their names, which you must specify in square brackets:

```
$rawtext = "If it interests you, my e-mail address is tobias@powershell.com."
# Simple pattern recognition:
$rawtext -match "\b[A-Z0-9._%+-]+@[A-Z0-9.-]+\.[A-Z]{2,4}\b"

  True

# Reading data matching the pattern from raw text:
$matches

  Name                           Value
  ----                           -----
  0                              tobias@powershell.com

$matches[0]

  tobias@powershell.com
```

Does that also work for more than one e-mail addresses in text? Unfortunately, it doesn't do so right away. The *-match* operator looks only for the first matching expression. So, if you want to find more than one occurrence of a pattern in raw text, you have to switch over to the *RegEx* object underlying the *-match* operator and use it directly.

In one essential respect, the *RegEx* object behaves unlike the *-match* operator. Case sensitivity is the default for the *RegEx* object, but not for *-match*. For this reason, you must put the "*(?i)*" option in front of the regular expression to eliminate confusion, making sure the expression is evaluated without taking case sensitivity into account.

```
# A raw text contains several e-mail addresses. -match finds the first one only:
$rawtext = "test@test.com sent an e-mail that was forwarded to spam@muell.de."
$rawtext -match "\b[A-Z0-9._%+-]+@[A-Z0-9.-]+\.[A-Z]{2,4}\b"

  True

$matches

  Name                           Value
  ----                           -----
  0                              test@test.com

# A RegEx object can find any pattern but is case sensitive by default:
$regex = [regex]"(?i)\b[A-Z0-9._%+-]+@[A-Z0-9.-]+\.[A-Z]{2,4}\b"
$regex.Matches($rawtext)

  Groups   : {test@test.com}
  Success  : True
  Captures : {test@test.com}
  Index    : 4
  Length   : 13
  Value    : test@test.com
  Groups   : {spam@muell.de}
  Success  : True
  Captures : {spam@muell.de}
  Index    : 42
  Length   : 13
  Value    : spam@muell.de

# Limit result to e-mail addresses:
$regex.Matches($rawtext) | Select-Object -Property Value

  Value
  -----
  test@test.com
  spam@muell.de

# Continue processing e-mail addresses:
$regex.Matches($rawtext) | ForEach-Object { "found: $($_.Value)" }

  found: test@test.com
  found: spam@muell.de
```

Searching for Several Keywords

You can use the alternation construct "|" to search for a group of keywords, and then find out which keyword was actually found in the string:

```
"Set a=1" -match "Get|GetValue|Set|SetValue"

  True

$matches

  Name                           Value
  ----                           -----
  0                              Set
```

$matches tells you which keyword actually occurs in the string. But note the order of keywords in your regular expression—it's crucial because the first matching keyword is the one selected. In this example, the result would be incorrect:

```
"SetValue a=1" -match "Get|GetValue|Set|SetValue"

  True

$matches[0]

  Set
```

Either change the order of keywords so that longer keywords are checked before shorter ones â€¦:

```
"SetValue a=1" -match "GetValue|Get|SetValue|Set"

  True

$matches[0]

  SetValue
```

... or make sure that your regular expression is precisely formulated, and remember that you're actually searching for single words. Insert word boundaries into your regular expression so that sequential order no longer plays a role:

```
"SetValue a=1" -match "\b(Get|GetValue|Set|SetValue)\b"

  True

$matches[0]

  SetValue
```

It's true here, too, that *-match* finds only the first match. If your raw text has several occurrences of the keyword, use a *RegEx* object again:

```
$regex = [regex]"\b(Get|GetValue|Set|SetValue)\b"
$regex.Matches("Set a=1; GetValue a; SetValue b=12")

  Groups   : {Set, Set}
  Success  : True
  Captures : {Set}
  Index    : 0
  Length   : 3
  Value    : Set
  Groups   : {GetValue, GetValue}
  Success  : True
  Captures : {GetValue}
  Index    : 9
  Length   : 8
  Value    : GetValue
  Groups   : {SetValue, SetValue}
  Success  : True
  Captures : {SetValue}
  Index    : 21
  Length   : 8
  Value    : SetValue
```

Forming Groups

A raw text line is often a heaping trove of useful data. You can use parentheses to collect this data in sub-expressions so that it can be evaluated separately later. The basic principle is that all the data that you want to find in a pattern should be wrapped in parentheses because *$matches* will return the results of these sub-expressions as independent elements. For example, if a text line contains a date first, then text, and if both are separated by tabs, you could describe the pattern like this:

```
# Defining pattern: two characters separated by a tab
$pattern = "(.*)\t(.*)"
# Generate example line with tab character
$line = "12/01/2009`tDescription"
# Use regular expression to parse line:
$line -match $pattern

  True

# Show result:
$matches

  Name                            Value
  ----                            -----
  2                               Description
  1                               12/01/2009
  0                               12/01/2009    Description

$matches[1]

  12/01/2009

$matches[2]

  Description
```

When you use sub-expressions, *$matches* will contain the entire searched pattern in the first array element named "0". Sub-expressions defined in parentheses follow in additional elements. To make them easier to read and understand, you can assign sub-expressions their own names and later use the names to call results. To assign names to a sub-expression, type *?<Name>* in parentheses for the first statement:

```
# Assign subexpressions their own names:
$pattern = "(?<Date>.*)\t(?<Text>.*)"
# Generate example line with tab character:
$line = "12/01/2009`tDescription"
# Use a regular expression to parse line:
$line -match $pattern

  True

# Show result:
$matches
```

```
  Name                        Value
  ----                        -----
  Text                        Description
  Date                        12/01/2009
  0                           12/01/2009    Description

$matches.Date

  12/01/2009

$matches.Text

  Description
```

Each result retrieved by *$matches* for each sub-expression naturally requires storage space. If you don't need the results, discard them to increase the speed of your regular expression. To do so, type "?:" as the first statement in your sub-expression:

```
# Don't return a result for the second subexpression:
$pattern = "(?<Date>.*)\t(?:.*)"
# Generate example line with tab character:
$line = "12/01/2009`tDescription"
# Use a regular expression to parse line:
$line -match $pattern

  True

# No more results will be returned for the second subexpression:
$matches

  Name                       Value
  ----                       -----
  Date                       12/01/2009
  0                          12/01/2009    Description
```

Further Use of Sub-Expressions

With the help of results from each sub-expression, you can create surprisingly flexible regular expressions. For example, how could you define a Web site HTML tag as a pattern? A tag always has the same structure: *<tagname [parameter]>...</tagname>*. This means that a pattern for one particular strictly predefined HTML tag can be found quickly:

```
"<body background=1>contents</body>" -match "<body\b[^>]*>(.*?)</body>"

  True

$matches[1]

  Contents
```

The pattern begins with the fixed text "<body". Any additional words, separated by word boundaries, may follow with the exception of ">". The concluding ">" follows and then the contents of the *body* tag, which may consist of any number of any characters (.*?). The expression, enclosed in parentheses, is a sub-expression and will be returned later as a result in *$matches* so that you'll know what is inside the *body* tag. The concluding part of the tag follows in the form of fixed text ("</body").

This regular expression works fine for *body* tags, but not for other tags. Does this mean that a regular expression has to be defined for every HTML tag? Naturally not. There's a simpler solution. The problem is that the name of the tag in the regular expression occurs twice, once initially ("<body...>") and once terminally ("</body>"). If the regular expression is supposed to be able to process any tags, then it would have to be able to find out the name of the tag automatically and use it in both locations. How to accomplish that? Like this:

```
"<body background=2>Contents</body>" -match "<([A-Z][A-Z0-9]*)[^>]*>(.*?)</\1>"

  True

$matches

  Name                           Value
  ----                           -----
  2                              Contents
  1                              body
  0                              <body background=2>Contents</body>
```

This regular expression no longer contains a strictly predefined tag name and works for any tags matching the pattern. How does that work? The initial tag in parentheses is defined as a sub-expression, more specifically as a word that begins with a letter and that can consist of any additional alphanumeric characters.

```
([A-Z][A-Z0-9]*)
```

The name of the tag revealed here must subsequently be iterated in the terminal part. Here you'll find "</\1>". "\1" refers to the result of the first sub-expression. The first sub-expression evaluated the tag name and so this name is used automatically for the terminal part.

The following *RegEx* object could directly return the contents of any HTML tag:

```
$regexTag = [regex]"(?i)<([A-Z][A-Z0-9]*)[^>]*>(.*?)</\1>"
$result = $regexTag.Matches("<button>Press here</button>")
$result[0].Groups[2].Value + " is in tag " + $result[0].Groups[1].Value

  Press here is in tag button
```

Greedy or Lazy? Detailed or Concise Results...

Readers who have paid careful attention may wonder why the contents of the HTML tag were defined by ".*?" and not simply by ".*" in regard to regular expressions. . After all, ".*" should suffice so that an arbitrary character (char: ".") can turn up any number of times (quantifier: "*"). At first glance, the difference between ".*" and ".*? is not easy to recognize; but a short example should make it clear.

Assume that you would like to evaluate month specifications in a logging file, but the months are not all specified in the same way. Sometimes you use the short form, other times the long form of the month name is used. As you've seen, that's no problem for regular expressions, because sub-expressions allow parts of a keyword to be declared optional:

```
"Feb" -match "Feb(ruary)?"

  True

$matches[0]

  Feb

"February" -match "Feb(ruary)?"

  True

$matches[0]

  February
```

In both cases, the regular expression recognizes the month, but returns different results in *$matches*. By default, the regular expression is "greedy" and wants to achieve a match in as much detail as possible. If the text is "February," then the expression will search for a match starting with "Feb" and then continue searching "greedily" to check whether even more characters match the pattern. If they do, the entire (detailed) text is reported back.

However, if your main concern is just standardizing the names of months, you would probably prefer getting back the shortest common text. That's exactly what the "??" quantifier does, which in contrast to the regular expression is "lazy." As soon as it recognizes a pattern, it returns it without checking whether additional characters might match the pattern optionally.

```
"Feb" -match "Feb(ruary)?"

  True

$matches[0]

  Feb

"February" -match "Feb(ruary)?"
```

```
    True

  $matches[0]

    Feb
```

Just what is the connection between the "??" quantifier of this example and the "*?" if the preceding example? In reality, "*?" is not a self-contained quantifier. It just turns a normally "greedy" quantifier into a "lazy" quantifier. This means you could use "?" to force the quantifier "*" to be "lazy" and to return the shortest possible result. That's exactly what happened with our regular expressions for HTML tags. You can see how important this is if you use the greedy quantifier "*" instead of "*?", then it will attempt to retrieve a result in as much detail as possible. That can go wrong:

```
  # The greedy quantifier * returns results in as much detail as possible:
  "<body background=1>Contents</body></body>" -match "<body\b[^>]*>(.*)</body>"

    True

  $matches[1]

    Contents<\body>

  # The right quantifier is *?, the lazy one, which returns results that
  # are as short as possible
  "<body background=1>Contents</body></body>" -match "<body\b[^>]*>(.*?)</body>"

    True

  $matches[1]

    Contents
```

According to the definition of the regular expression, any characters are allowed inside the tag. Moreover, the entire expression must end with "</body>". If "</body>" is also inside the tag, the following will happen: the greedy quantifier ("*"), coming across the first "</body>", will at first assume that the pattern is already completely matched. But because it is greedy, it will continue to look and will discover the second "</body>" that also fits the pattern. The result is that it will take both "</body>" specifications into account, allocate one to the contents of the tag, and use the other as the conclusion of the tag.

I this example, it would be better to use the lazy quantifier ("*?") that notices when it encounters the first "</body>" that the pattern is already correctly matched and consequently doesn't go to the trouble of continuing to search. It will ignore the second "</body>" and use the first to conclude the tag.

Finding String Segments

Entire books have been written about the uses of regular expressions. That's why it would go beyond the scope of this book to discuss more details. However, our last example, which locates text segments, shows how you can use the elements listed in Table 13.11 to easily harvest surprising search results. If you type two words, the regular expression will retrieve the text segment between the two words if at least one word is, and not more than six other words are, between the two words:

```
"Find word segments from start to end" -match "\bstart\W+(?:\w+\W+){1,6}?end\b"
True
$matches[0]

  Name                           Value
  ----                           -----
  0                              start to end
```

Replacing a String

You already know how to replace a string because you were already introduced to the *-replace* operator. Simply tell the operator what term you want to replace in a string and the task is done:

```
"Hello, Ralph" -replace "Ralph", "Martina"

  Hello, Martina
```

But simple replacement isn't always sufficient, so you need to use regular expressions for replacements. Some of the following interesting examples show how that could be useful.

Perhaps you'd like to replace several different terms in a string with one other term. Without regular expressions, you'd have to replace each term separately. Or use instead the alternation operator, "|", with regular expressions:

```
"Mr. Miller and Mrs. Meyer" -replace "(Mr.|Mrs.)", "Our client"

  Our client Miller and Our client Meyer
```

You can type any term in parentheses and use the "|" symbol to separate them. All the terms will be replaced with the replacement string you specify.

Using Back References

This last example replaces specified keywords anywhere in a string. Often, that's sufficient, but sometimes you don't want to replace a keyword everywhere it occurs but only when it occurs in a certain context. In such cases, the context must be defined in some way in the pattern. How could you change the regular expression so that it replaces only the names Miller and Meyer? Like this:

```
"Mr. Miller, Mrs. Meyer and Mr. Werner" `
```

```
    -replace "(Mr.|Mrs.)\s*(Miller|Meyer)", "Our client"

    Our client, Our client and Mr. Werner
```

The result looks a little peculiar, but the pattern you're looking for was correctly identified. The only replacements were *Mr.* or *Mrs. Miller* and *Mr.* or *Mrs. Meyer*. The term "Mr. Werner" wasn't replaced. Unfortunately, the result also shows that it doesn't make any sense here to replace the entire pattern. At least the name of the person should be retained. Is that possible?

This is where the back referencing you've already seen comes into play. Whenever you use parentheses in your regular expression, the result inside the parentheses is evaluated separately, and you can use these separate results in your replacement string. The first sub-expression always reports whether a "Mr." or a "Mrs." was found in the string. The second sub-expression returns the name of the person. The terms "$1" and "$2" provide you the sub-expressions in the replacement string (the number is consequently a sequential number; you could also use "$3" and so on for additional sub-expressions).

```
  "Mr. Miller, Mrs. Meyer and Mr. Werner" `
   -replace "(Mr.|Mrs.)\s*(Miller|Meyer)", "Our client $2"

    Our client , Our client  and Mr. Werner
```

Strangely enough, at first the back references don't seem to work. The cause can be found quickly: "$1" and "$2" look like PowerShell variables, but in reality they are regular terms of the *-replace* operator. As a result, if you put the replacement string inside double quotation marks, PowerShell will replace "$2" with the PowerShell variable $2, which is normally empty. So that replacement with back references works, consequently, you must either put the replacement string inside single quotation marks or add a backtick to the "$" special character so that PowerShell won't recognize it as its own variable and replace it:

```
  # Replacement text must be inside single quotation marks
  # so that the PS variable $2:
  "Mr. Miller, Mrs. Meyer and Mr. Werner" -replace `
    "(Mr.|Mrs.)\s*(Miller|Meyer)", 'Our client $2'

    Our client Miller, Our client Meyer and Mr. Werner

  # Alternatively, $ can also be masked by `$:
  "Mr. Miller, Mrs. Meyer and Mr. Werner" -replace `
    "(Mr.|Mrs.)\s*(Miller|Meyer)", "Our client `$2"

    Our client Miller, Our client Meyer and Mr. Werner
```

Putting Characters First at Line Beginnings

Replacements can also be made in multiple instances in text of several lines. For example, when you respond to an e-mail, usually the text of the old e-mail is quoted in your new e-mail as and marked with ">" at the beginning of each line. Regular expressions can do the marking.

However, to accomplish this, you need to know a little more about "multi-line" mode. Normally, this mode is turned off, and the "^" anchor represents the text beginning and the "$" the text ending. So that these two anchors refer respectively to the line beginning and line ending of a text of several lines, the multi-line mode must be turned on with the "(?m)" statement. Only then will *-replace* substitute the pattern in every single line. Once the multi-line mode is turned on, the anchors "^" and "\A", as well as "$" and "\Z", will suddenly behave differently. "\A" will continue to indicate the text beginning, while "^" will mark the line ending; "\Z" will indicate the text ending, while "$" will mark the line ending.

```
# Using Here-String to create a text of several lines:
$text = @"
Here is a little text.
I want to attach this text to an e-mail as a quote.
That's why I would put a ">" before every line.
"@
$text

  Here is a little text.
  I want to attach this text to an e-mail as a quote.
  That's why I would put a ">" before every line.

# Normally, -replace doesn't work in multiline mode.
# For this reason, only the first line is replaced:
$text -replace "^", "> "

  > Here is a little text.
  I want to attach this text to an e-mail as a quote.
  That's why I would put a ">" before every line.

# If you turn on multiline mode, replacement will work in every line:
$text -replace "(?m)^", "> "

  > Here is a little text.
  > I want to attach this text to an e-mail as a quote.
  > That's why I would put a ">" before every line.

# The same can also be accomplished by using a RegEx object,
# where the multiline option must be specified:
[regex]::Replace($text, "^", "> ", `
  [Text.RegularExpressions.RegExOptions]::Multiline)

  > Here is a little text.
  > I want to attach this text to an e-mail as a quote.
  > That's why I would put a ">" before every line.

# In multiline mode, \A stands for the text beginning
#  and ^ for the line beginning:
[regex]::Replace($text, "\A", "> ", `
  [Text.RegularExpressions.RegExOptions]::Multiline)

  > Here is a little text.
  I want to attach this text to an e-mail as a quote.
```

```
    That's why I would put a ">" before every line.
```

Removing Superfluous White Space

Regular expressions can perform routine tasks as well, such as remove superfluous white space. The pattern describes a blank character (char: "\s") that occurs at least twice (quantifier: "{2,}"). That is replaced with a normal blank character.

```
"Too   many   blank   characters" -replace "\s{2,}", " "

  Too many blank characters
```

Finding and Removing Doubled Words

How is it possible to find and remove doubled words in text? Here, you can use back referencing again. The pattern could be described as follows:

```
"\b(\w+)(\s+\1){1,}\b"
```

The pattern searched for is a word (anchor: "\b"). It consists of one word (the character "\w" and quantifier "+"). A blank character follows (the character "\s" and quantifier "?"). This pattern, the blank character and the repeated word, must occur at least once (at least one and any number of iterations of the word, quantifier "{1,}"). The entire pattern is then replaced with the first back reference, that is, the first located word.

```
# Find and remove doubled words in a text:
"This this this is a test" -replace "\b(\w+)(\s+\1){1,}\b", '$1'

  This is a test
```

Summary

Text is demarcated either by single or double quotation marks. If you use double quotation marks, PowerShell will replace PowerShell variables and special characters in text. Text enclosed in single quotation marks will remain unchanged. The same is true for characters in text marked with the backtick character, which can be used to insert special characters in the text (Table 13.1).

The user can query text directly through the Read-Host cmdlet. Lengthier text, text of several lines, can also be inputted through Here-Strings, which are begun with @"(Enter) and ended with "@(Enter).

By using the format operator -f, you can output formatted text. This gives you the option to display text in different ways or to set fixed widths to output text in aligned columns (Table 13.3 through Table 13.5). Along with the formatting operator, PowerShell has a number of further string operators you can use to validate patterns or to replace a string (Table 13.2). Most of these operators are also available in two special forms, which are either case-insensitive (preceded by "i") or case-sensitive (preceded by "c").

PowerShell stores text in string objects, which contain dynamic methods to work on the stored text. You can use these methods by typing a dot after the string object (or the variable in which the text is stored) and then activating auto complete (Table 13.6). Along with the dynamic methods that always refer to text stored in a string object, there are also static methods that are provided directly by the string data type by qualifying the string object with "[string]::".

The simplest way to describe patterns is to use the simple wildcards in Table 13.7. This allows you to check whether text is recognized in a particular pattern. However, simple wildcards are appropriate tools only for rudimentary pattern recognition. Moreover, simple wildcards can only recognize patterns; they cannot extract data from them. A far more sophisticated tool is regular expressions. They consist of the diverse elements listed in Table 13.11, consisting basically of the categories "character," "quantifier," and "anchor." Regular expressions describe any complex pattern and can be used along with the operators *-match* or *-replace*. Use the .NET object [regex] if you want to be very specific and utilize advanced functionality of regular expressions.

The *-match* operator reports whether the string contains the pattern you're looking for and subsequently retrieves the contents of the pattern in the *$matches* variable. This means that you can use *-match* not only to recognize patterns, but also to parse unstructured data directly. The *-replace* operator searches for a pattern and replaces it with an alternative string. Both operators also support back references, whose use was explained in detail in several chapter examples.

CHAPTER 14.

XML

Raw information used to be stored in comma-separated lists or .ini files, but for some years the XML standard has prevailed. XML is an acronym for Extensible Markup Language and is a descriptive language for any structured information. In the past, handling XML was difficult, but PowerShell now has excellent XML support. With its help, you can comfortably wrap data in XML as well as read existing XML files.

Topics Covered:

XML Structure

XML uses *tags* to uniquely identify pieces of information. A tag is a pair of angle brackets like the ones used for HTML documents in a Web site. Typically, a piece of information is delimited by a start and end tag. The end tag is preceded by "/"; the result is known as a node, which in this case is called *Name*:

```
<Name>Tobias Weltner</Name>
```

In addition, nodes possess attributes, or information relating to the node itself. This information is in the introductory tag:

```
<staff branch="Hanover" Type="sales">...</staff>
```

If a node is empty, the start and end tags can be collapsed. The ending symbol "/" drifts toward the end of the tag. If the branch office in Hanover doesn't have any staff currently working in the sales department, the tag will look like this:

```
<staff branch="Hanover" Type="sales"/>
```

Usually, though, nodes aren't empty and they contain further information, which in turn is included in tags. This allows reproduction of information structures that can be nested as deeply as you like. The following XML structure describes two staff members of the Hanover branch office who are working in the sales department.

```
<staff branch="Hanover" Type="sales">
```

```
    <employee>
      <Name>Tobias Weltner</Name>
      <function>management</function>
      <age>39</age>
    </employee>
    <employee>
      <Name>Cofi Heidecke</Name>
      <function>security</function>
      <age>4</age>
    </employee>
  </staff>
```

So that XML files can be recognized as such, they usually begin with a header, which in a very simple case might look like this:

```
<?xml version="1.0" ?>
```

This header declares that the subsequent XML conforms to the specifications of XML version 1.0. What is known as a "schema" could also be given here. Specifically, a schema has the form of an XSD (*XML Schema Definition*) file and describes what the valid structure of the XML file should be to fulfill a certain purpose. In the previous example, the schema could specify that there must always be a node called "staff" as part of staff information, which in turn could include as many sub-nodes named "staff" as required. The schema would also specify that information relating to name and function must also be defined for each staff member.

Because XML files consist of plain text, you can easily create them using any editor or directly from within PowerShell. Let's save the previous staff list as an *xml* file:

```
$xml = @'
<?xml version="1.0" standalone="yes"?>
<staff branch="Hanover" Type="sales">
  <employee>
    <Name>Tobias Weltner</Name>
    <function>management</function>
    <age>39</age>
  </employee>
  <employee>
    <Name>Cofi Heidecke</Name>
    <function>security</function>
    <age>4</age>
  </employee>
</staff>
'@ | Out-File employee.xml
```

note

XML is case-sensitive!

Loading and Processing XML Files

If you want to process XML files as actual XML and not as text, the text contents must be converted into the XML type. The type conversion covered in Chapter 6 performs this task in just one line:

```
$xmldata = [xml](Get-Content employee.xml)
```

Use *Get-Content* to read the XML from the previously saved *xml* file and *[xml]* to convert the XML into genuine XML. You could just as easily have directly specified the XML from the *$xml* variable:

```
$xmldata = [xml]$xml
```

However, conversion works only if the specified XML is also valid and contains no syntactic errors. You'll get an error when trying to convert if the structure of your XML is faulty.

The structure of information that describes the XML is now included in *$xmldata*. From now on, it will be very easy to retrieve single pieces of information because the XML object represents each node as attributes. You can get a staff list like this:

```
$xmldata.staff.employee

  Name              Function         Age
  ----              -----          -----
  Tobias Weltner    management        39
  Cofi Heidecke     security           4
```

Accessing Single Nodes and Modifying Data

If a node in your XML is unique, you can access it by typing a dot as in the previous example. Often, however, XML documents contain many similar nodes (known as *siblings*) just as the last example includes individual employees. For example, you could use the PowerShell pipeline if you'd like to access a particular employee to modify his data:

```
$xmldata.staff.employee |
  Where-Object { $_.Name -match "Tobias Weltner" }

  Name                function           Age
  ----                -----            -----
  Tobias Weltner      management          39

$employee = $xmldata.staff.employee |
  Where-Object { $_.Name -match "Tobias Weltner" }
$employee.function = "vacation"
$xmldata.staff.employee

  Name                function           Age
  ----                -----            -----
  Tobias Weltner      vacation            39
  Cofi Heidecke       security             4
```

Using SelectNodes() to Choose Nodes

The *SelectNodes()* method, which the *XPath* query language supports, also allows you to select nodes. *XPath* specifies the "path name" to a node:

```
$xmldata = [xml](Get-Content employee.xml)
$xmldata.SelectNodes("staff/employee")

  Name                   function          Age
  ----                   ------          -----
  Tobias Weltner         management         39
  Cofi Heidecke          security            4
```

The result looks just like the direct accessing of attributes in the preceding example. However, *XPath* supports wildcards enclosed in square brackets. The next statement retrieves just the first employee node:

```
$xmldata.SelectNodes("staff/employee[1]")

  Name                     function           Age
  ----                     ------           -----
  Tobias Weltner           management          39
```

If you'd like, you can get a list of all employees who are under the age of 18:

```
$xmldata.SelectNodes("staff/employee[age<18]")

  Name                       function         Age
  ----                       ------         -----
  Cofi Heidecke              security           4
```

In a similar way, the query language will also retrieve the last employee on the list. Position specifications are also possible:

```
$xmldata.SelectNodes("staff/employee[last()]")
$xmldata.SelectNodes("staff/employee[position()>1]")
```

pro tip

Alternatively, you can also use what is known as the *XpathNavigator*, which you get by multiple type conversion from XML text:

```
# Create navigator for XML:
$xpath = [System.XML.XPath.XPathDocument]`
[System.IO.TextReader][System.IO.StringReader]`
(Get-Content employee.xml | out-string)
$navigator = $xpath.CreateNavigator()
# Output the last employee name of the Hanover branch office:
$query = "/staff[@branch='Hanover']/employee[last()]/Name"
$navigator.Select($query) | Format-Table Value
```

```
  Value
  -----
  Cofi Heidecke

# Output all employees for the Hanover branch office
# except for Tobias Weltner:
$query = "/staff[@branch='Hanover']/employee[Name!='Tobias
Weltner']"
$navigator.Select($query) | Format-Table Value

  Value
  -----
  Cofi Heideckesecurity4
```

Accessing Attributes

Attributes are information defined in an XML tag. If you'd like to see the attributes of a node, use *get_Attributes()*:

```
$xmldata.staff.get_Attributes()

  #text
  -----
  Hanover
  sales
```

Use *GetAttribute() i* f you'd like to query a particular attribute:

```
$xmldata.staff.GetAttribute("branch")

  Hanover
```

Use *SetAttribute()* to specify new attributes or modify (overwrite) existing ones:

```
$xmldata.staff.SetAttribute("branch", "New York")
$xmldata.staff.GetAttribute("branch")

  New York
```

Adding New Nodes

If you'd like to add the names of new employees to the employee list, first use *CreateElement()* to create an employee element and then to lay down its inner structure. Afterwards, the element can be inserted at the desired location in the XML structure:

```
# Load XML from file:
$xmldata = [xml](Get-Content employee.xml)
# Create new node:
$newemployee = $xmldata.CreateElement("employee")
$newemployee.set_InnerXML( `
  "<Name>Bernd Seiler</Name><function>expert</function>")
# Write nodes in XML:
$xmldata.staff.AppendChild($newemployee)
# Check result:
$xmldata.staff.employee

  Name                 Function          Age
  ----                 -----            -----
  Tobias Weltner       management          39
  Cofi Heidecke        security             4
  Bernd Seiler         expert

# Output plain text:
$xmldata.get_InnerXml()

  <?xml version="1.0"?><Branch office staff="Hanover" Type="sales">
  <employee><Name>Tobias Weltner</Name><function>management</function>
  <age>39</age></employee><employee><Name>Cofi Heidecke</Name>
  <function>security</function><age>4</age></employee><employee>
  <Name>Bernd Seiler</Name><function>expert</function></employee></staff>
```

Exploring the Extended Type System

The PowerShell Extended Type System (ETS) ensures that objects can be converted into meaningful text; moreover, it can pass additional properties and methods to objects. The precise instructions for these operations are laid down in XML files having the *.ps1xml* file extension.

The XML Data of the Extended Type System

Whenever PowerShell has to convert an object into text, it searches through several of its own internal records to find any that describe the object and its conversion. The right files contain XML; their name ends with *.format.ps1xml*. These files are located in the PowerShell root directory *$pshome*:

```
Dir $pshome\*.format.ps1xml

  Mode                LastWriteTime     Length Name
  ----                -------------     ------ ----
  -a---         4/13/2007     19:40      22120 Certificate.format.ps1xml
  -a---         4/13/2007     19:40      60703 DotNetTypes.format.ps1xml
  -a---         4/13/2007     19:40      19730 FileSystem.format.ps1xml
  -a---         4/13/2007     19:40     250197 Help.format.ps1xml
  -a---         4/13/2007     19:40      65283 PowerShellCore.format.ps1xml
  -a---         4/13/2007     19:40      13394 PowerShellTrace.format.ps1xml
```

```
   -a---          4/13/2007     19:40      13540 Registry.format.ps1xml
```

All these files define a multitude of *Views*, which you can examine using PowerShell XML support.

```
[xml]$file = Get-Content "$pshome\dotnettypes.format.ps1xml"
$file.Configuration.ViewDefinitions.View

   Name                                ViewSelectedBy    TableControl
   ----                                --------------    ------------
   System.Reflection.Assembly          ViewSelectedBy    TableControl
   System.Reflection.AssemblyName      ViewSelectedBy    TableControl
   System.Globalization.CultureInfo    ViewSelectedBy    TableControl
   System.Diagnostics.FileVersionInfo  ViewSelectedBy    TableControl
   System.Diagnostics.EventLogEntry    ViewSelectedBy    TableControl
   System.Diagnostics.EventLog         ViewSelectedBy    TableControl
   System.Version                      ViewSelectedBy    TableControl
   System.Drawing.Printing.PrintDo...  ViewSelectedBy    TableControl
   Dictionary                          ViewSelectedBy    TableControl
   ProcessModule                       ViewSelectedBy    TableControl
   process                             ViewSelectedBy    TableControl
   PSSnapInInfo                        ViewSelectedBy
   PSSnapInInfo                        ViewSelectedBy    TableControl
   Priority                            ViewSelectedBy    TableControl
   StartTime                           ViewSelectedBy    TableControl
   service                             ViewSelectedBy    TableControl
   (...)
```

Finding Predefined Views

Predefined views are highly interesting because you can use the -*view* parameter to make extensive adjustments and modifications of results given by formatting cmdlets like *Format-Table* or *Format-List*.

```
Get-Process | Format-Table -view Priority
Get-Process | Format-Table -view StartTime
```

Unfortunately, there's nobody to inform you of the availability of the *Priority* and *StartTime* predefined views or of other views. You can look in the relevant XML files. The view shows that every view node contains the child nodes *Name*, *ViewSelectedBy*, and *TableControl*. But the raw XML data of the view may look confusing and unclear at first:

```
$xmldata = $file.Configuration.ViewDefinitions.View |
  Select-Object -first 1
$xmldata.get_OuterXML()
```

A little re-formatting results in text that's easier to read:

```
$xmldata.get_OuterXML().Replace("<", "`t<").Replace(">", ">`t")`
.Replace(">`t`t<", ">`t<").Split("`t") |
ForEach-Object {$x=0}{ If ($_.StartsWith("</")) {$x--} `
ElseIf($_.StartsWith("<")) { $x++}; (" " * ($x)) + $_; `
if ($_.StartsWith("</")) { $x--} elseif `
($_.StartsWith("<")) {$x++} }

  <View>
     <Name>
      System.Reflection.Assembly
     </Name>
    <ViewSelectedBy>
       <TypeName>
        System.Reflection.Assembly
       </TypeName>
     </ViewSelectedBy>
     <TableControl>
       <TableHeaders>
         <TableColumnHeader>
           <Label>
            GAC
           </Label>
           <Width>
            6
           </Width>
         </TableColumnHeader>
         <TableColumnHeader>
           <Label>
            Version
           </Label>
          <Width>
            14
           </Width>
         </TableColumnHeader>
         <TableColumnHeader />
        </TableHeaders>
         <TableRowEntries>
           <TableRowEntry>
             <TableColumnItems>
               <TableColumnItem>
                 <PropertyName>
                 GlobalAssemblyCache
                 </PropertyName>
              </TableColumnItem>
               <TableColumnItem>
                 <PropertyName>
                  ImageRuntimeVersion
                 </PropertyName>
              </TableColumnItem>
               <TableColumnItem>
                 <PropertyName>
                  Location
                 </PropertyName>
               </TableColumnItem>
             </TableColumnItems>
          </TableRowEntry>
         </TableRowEntries>
      </TableControl>
     </View>
```

Each view consists of a *Name*, a .NET type in *ViewSelectedBy* for which the view is valid, as well as the *TableControl* node specifying how the object is supposed to be converted into text. Just use *Format-Table* to output the data if you want to output all the views specified in the XML file in columns, . Then, select the properties that you want to show in the summary:

```
[xml]$file = Get-Content "$pshome\dotnettypes.format.ps1xml"
$file.Configuration.ViewDefinitions.View |
  Format-Table Name, {$_.ViewSelectedBy.TypeName}

   Name                                          $_.ViewSelectedBy.TypeName
   ----                                          --------------------------
   System.Reflection.Assembly                    System.Reflection.Assembly
   System.Reflection.AssemblyName                System.Reflection.AssemblyName
   System.Globalization.CultureInfo              System.Globalization.CultureInfo
   System.Diagnostics.FileVersionInfo            System.Diagnostics.FileVersionInfo
   System.Diagnostics.EventLogEntry              System.Diagnostics.EventLogEntry
   System.Diagnostics.EventLog                   System.Diagnostics.EventLog
   System.Version                                System.Version
   System.Drawing.Printing.PrintDocument
   System.Drawing.Printing.PrintDocument
   Dictionary                                    System.Collections.DictionaryEntry
   ProcessModule                                 System.Diagnostics.ProcessModule
   process                                       {System.Diagnostics.Process,
   Deserialized.Sy...
   PSSnapInInfo
   System.Management.Automation.PSSnapInInfo
   PSSnapInInfo
   System.Management.Automation.PSSnapInInfo
   Priority                                      System.Diagnostics.Process
   StartTime                                     System.Diagnostics.Process
   service
   System.ServiceProcess.ServiceController
   System.Diagnostics.FileVersionInfo            System.Diagnostics.FileVersionInfo
   System.Diagnostics.EventLogEntry              System.Diagnostics.EventLogEntry
   System.Diagnostics.EventLog                   System.Diagnostics.EventLog
   System.TimeSpan                               System.TimeSpan
   System.TimeSpan                               System.TimeSpan
   System.TimeSpan                               System.TimeSpan
   System.AppDomain                              System.AppDomain
   System.ServiceProcess.ServiceController
   System.ServiceProcess.ServiceController
   System.Reflection.Assembly                    System.Reflection.Assembly
   System.Collections.DictionaryEntry            System.Collections.DictionaryEntry
   process                                       System.Diagnostics.Process
   DateTime                                      System.DateTime
   System.Security.AccessControl.ObjectSecurity
   System.Security.AccessControl.ObjectSecurity
```

```
    System.Security.AccessControl.ObjectSecurity
    System.Security.AccessControl.ObjectSecurity
    System.Management.ManagementClass             System.Management.ManagementClass
```

Here you see all of the views defined in this XML file. The object types for which the views are defined are in the second column. The *Priority* and *StartTime* views, which we just used, are also on the list. After a look at the second column, it should be clear that the views are intended for *System.Diagnostics.Process* objects, precisely the objects that *Get-Process* retrieves:

```
(Get-Process | Select-Object -first 1).GetType().FullName

  System.Diagnostics.Process
```

Surprisingly, doubles of some names crop up. The reason is that, along with the *TableControl* node in the last example, other nodes convert objects: *ListControl*, *WideControl* and *CustomControl*. These nodes weren't displayed in the first overview simply because only one node of this kind is allowed for each view. A *TableControl* was output more or less randomly since PowerShell bases its text conversion of unknown objects on the first record.

You are now in a position to extract all required information from the XML file. First, sort the views by *ViewSelectedBy.TypeName*, and then group them by this criterion. You can sort out all the views that match only once for a particular object type. You need only those views of which several exist for an object type, making it worthwhile to use the *-view* parameter for the selection.

```
[xml]$file = Get-Content "$pshome\dotnettypes.format.ps1xml"
$file.Configuration.ViewDefinitions.View |
  Sort-Object {$_.ViewSelectedBy.TypeName} |
  Group-Object {$_.ViewSelectedBy.TypeName} |
  Where-Object { $_.Count -gt 1} |
  ForEach-Object { $_.Group} |
  Format-Table Name, {$_.ViewSelectedBy.TypeName}, `
  @{expression={if ($_.TableControl) { "Table" } elseif `
  ($_.ListControl) { "List" } elseif ($_.WideControl) { "Wide" } `
  elseif ($_.CustomControl) { "Custom" }};label="Type"} -wrap
```

tip

If you're wondering about the formatting of these lines, take a look again at Chapter 5, which covered formatting. What's important about formatting cmdlets like *Format-Table* and others is that they make it possible for you to specify object properties or scriptblocks as columns. Sub-expressions are mandatory as long as what you want to display in a column is not the direct but subordinate property of the object. Because you aren't interested in the direct property *ViewSelectedBy* but rather in its sub-property *TypeName,* the column would have to be defined as a scriptblock. The third column is also a scriptblock. Because its length conflicts with the column heading, a formatting hash table should be applied here to permit you to select the column heading.

The result is an edited list that provides you with the names of all the views in the first column. The view that is appropriate for a respective object type is in the second column. The third column shows whether a view is meant for *Format-Table*, *Format-List*, *Format-Wide* or *Format-Custom*.

```
Name                   $_.ViewSelectedBy.TypeName           Type
----                   --------------------------           ----
Dictionary             System.Collections.DictionaryEntry   Table
System.Collections.    System.Collections.DictionaryEntry   List
DictionaryEntry
System.Diagnostics.    System.Diagnostics.EventLog          Table
EventLog
System.Diagnostics.    System.Diagnostics.EventLog          List
EventLog
System.Diagnostics.    System.Diagnostics.EventLogEntry     List
EventLogEntry
System.Diagnostics.    System.Diagnostics.EventLogEntry     Table
EventLogEntry
System.Diagnostics.    System.Diagnostics.FileVersionInfo   Table
FileVersionInfo
System.Diagnostics.    System.Diagnostics.FileVersionInfo   List
FileVersionInfo
Priority               System.Diagnostics.Process           Table
process                System.Diagnostics.Process           Wide
StartTime              System.Diagnostics.Process           Table
PSSnapInInfo           System.Management.Automation.        List
                       PSSnapInInfo
PSSnapInInfo           System.Management.Automation.        Table
                       PSSnapInInfo
System.Reflection.     System.Reflection.Assembly           Table
Assembly
System.Reflection.     System.Reflection.Assembly           List
Assembly
System.Security.       System.Security.AccessControl.       List
AccessControl.         ObjectSecurity
ObjectSecurity
System.Security.       System.Security.AccessControl.       Table
AccessControl.         ObjectSecurity
ObjectSecurity
service                System.ServiceProcess.               Table
                       ServiceController
System.ServiceProcess. System.ServiceProcess.               List
ServiceController      ServiceController
System.TimeSpan        System.TimeSpan                      List
System.TimeSpan        System.TimeSpan                      Wide
System.TimeSpan        System.TimeSpan                      Table
```

Remember that there are several XML files containing formatting information. You'll only get a full overview of them when you generate a list for all formatting XML files.

CHAPTER 15.

The File System

The file system has special importance within the PowerShell console. One obvious reason is that administrators perform many tasks that involve the file system. Another is that the file system is the prototype of a hierarchically structured information system. In coming chapters, you'll see that PowerShell controls other hierarchical information systems on this basis. You can easily apply what you have learned about drives, directories, and files in PowerShell to other areas, including the registry or Microsoft Exchange.

Topics Covered:

A number of cmdlets in Table 15.1 do the main work as they are rarely accessed under their real names. Aliases are much more useful and the aliases of cmdlets come from both the Windows and the UNIX worlds. This makes it easy for new learners to find the right cmdlets quickly.

Alias	**Description**	**Cmdlet**
ac	Adds the contents of a file	*Add-Content*
cls, clear	Clears the console window	*Clear-Host*
cli	Clears file of its contents, but not the file itself	*Clear-Item*
copy, cp, cpi	Copies file or directory	*Copy-Item*
Dir, ls, gci	Lists directory contents	*Get-Childitem*
type, cat, gc	Reads contents of text-based file	*Get-Content*
gi	Accesses specific file or directory	*Get-Item*
gp	Reads property of a file or directory	*Get-ItemProperty*
ii	Invokes file or directory using allocated Windows program	*Invoke-Item*
-	Joins two parts of a path into one path, for example, a drive and a file name	*Join-Path*
mi, mv, move	Moves files and directories	*Move-Item*
ni	Creates new file or new directory	*New-Item*

ri, rm, rmdir, del, erase, rd	Deletes empty directory or file	*Remove-Item*
rni, ren	Renames file or directory	*Rename-Item*
rvpa	Resolves relative path or path including wildcard characters	*Resolve-Path*
sp	Sets property of file or directory	*Set-ItemProperty*
Cd, chdir, sl	Changes to specified directory	*Set-Location*
-	Extracts a specific part of a path like the parent path, drive, or file name	*Split-Path*
-	Returns True if the specified path exists	*Test-Path*

Table 15.1: Overview of the most important file system commands

Accessing Files and Directories

Use *Get-ChildItem* to list the contents of a directory. The predefined aliases for this are *Dir* and *ls*. *Get-ChildItem* perform a number of important tasks:

- Making directory contents visible
- Searching through the file system recursively and finding certain files
- Getting files and directory objects
- Passing files to other cmdlets, functions, or scripts

Because Windows administrators use the alias *Dir* in practice, not the cmdlet *Get-ChildItem* by its name, *Dir* is used in the following examples. *Dir* can also be replaced by *ls* (UNIX) or *Get-ChildItem* in all examples.

Listing Directory Contents

In rudimentary cases, you may simply want to know which files are in a certain directory. If you don't specify another one, *Dir* lists the contents of the current directory. If you specify a directory after *Dir*, its contents will be listed. Also, if you use the *-recurse* parameter, *Dir* will list the contents of all subdirectories. Wildcard characters are also allowed.

For example, if you want to get a list of all PowerShell script files stored in the current directory, type this command:

```
Dir *.ps1
```

Dir even accepts arrays, which allow you to list different drives at the same time. The following instruction lists all the PowerShell scripts in the PowerShell root directory, as well as all log files in the Windows directory:

```
Dir $pshome\*.ps1, $env:windir\*.log
```

If you're interested only in the names of items in one directory, use the parameter *-name*. *Dir* will not retrieve objects (files and directories), but just their names in plain text.

```
Dir -name
```

note

Some characters have a special meaning in PowerShell, such as square brackets. Square brackets always designate array elements (see Chapter 4). That's why using file names can cause confusion. All special characters will be evaluated as path segments and won't be interpreted by PowerShell if you use the *-literalPath* parameter to specify file names.

Recursively Searching the Entire File System

Use the *-recurse* parameter if you want your search to include every subdirectory. However, note the failure of the following invocation:

```
Dir *.ps1 -recurse
```

You need to know a few more details about how *-recurse* works to understand why this happens,. *Dir* always retrieves directory contents as file and directory objects. If you set the *-recurse* switch, *Dir* will invoke directory objects recursively. Because you instructed *Dir* in the last example to retrieve only those files that had the *.ps1* extension, *Dir* found no directories that *-recurse* could have stepped through. The concept may be hard to get used to at first, but it explains why in the following example you get a recursive directory listing, even when you use wildcards:

```
Dir $home\d* -recurse
```

Here, *Dir* retrieves all the items from your root directory that begin with the letter "*D*". The directories are searched recursively as well because directories are among them.

Filter and Exclusion Criterion

But let's return to our initial problem: how to get a recursive listing of all files of one type, such as PowerShell scripts. The answer is to instruct *Dir* to list the directory contents completely and to specify a filter additionally. *Dir* then filters the files you want out of all the files:

```
Dir $home -filter *.ps1 -recurse
```

In addition to *-filter*, there is a parameter that at first glance works in a very similar way: *-include*:

```
Dir $home -include *.ps1 -recurse
```

You'll see some dramatic speed differences: *-filter* is much quicker than *-include*.

```
(Measure-Command {Dir $home -filter *.ps1 -recurse}).TotalSeconds

  4,6830099

(Measure-Command {Dir $home -include *.ps1 -recurse}).TotalSeconds

  28,1017376
```

The reason is that *-include* supports regular expressions, which are fundamentally more complicated, while *-filter* only understands simple wildcard characters. That's why you could use *-include* to make even more complex filters than the following ones, which find all script files beginning with one of the letters from "A" to "F". That's beyond the capacity of *-filter*:

```
# -filter looks for all files that begin with "[A-F]" and finds none:
Dir $home -filter [a-f]*.ps1 -recurse
# -include understands regular expressions and looks for files that begin with a-f
and end with .ps1:
Dir $home -include [a-f]*.ps1 -recurse

      Directory: Microsoft.PowerShell.Core\FileSystem::C:\Users\Tobias
  Weltner\Documents
  Mode                LastWriteTime     Length Name
  ----                -------------     ------ ----
  -a---        28.09.2007     23:59       1442 finddouble3.ps1
      Directory: Microsoft.PowerShell.Core\FileSystem::C:\Users\Tobias
  Weltner\Downloads\PowerShell
      CX-24134\Branches\Developer\rlehrbaum\Src\Pscx\Profile
  Mode                LastWriteTime     Length Name
  ----                -------------     ------ ----
  -a---        30.07.2007     08:40       6225 Cd.ps1
  -a---        30.07.2007     08:40       2083 Debug.ps1
  -a---        30.07.2007     08:40       1930 Dir.ps1
  -a---        30.07.2007     08:40       2279 Environment.ps1
```

```
    -a---         30.07.2007     08:40        2898 Environment.VisualStudio2005.ps1
    -a---         30.07.2007     08:40        1588 EyeCandy.Jachym.ps1
    -a---         30.07.2007     08:40        2096 EyeCandy.Keith.ps1
    -a---         30.07.2007     08:40        2254 EyeCandy.ps1
    -a---         30.07.2007     08:40         591 FileSystem.ps1
```

The counterpart to *-include* is *-exclude*. Use *-exclude* if you would like to suppress certain files. Unlike *-filter*, the *-include* and *-exclude* parameters accept arrays, which enables you to get a list of all image files in your profile:

```
Dir $home -recurse -include *.bmp,*.png,*.jpg, *.gif
```

Avoid just one thing: don't combine *-filter* and *-include*. Choose one of the two parameters. Specifically you should use *-filter* when you don't need any regular expressions or arrays because of its enormous speed advantage.

note

You can't use *Dir* to list files that have a certain size because with its filters, *Dir* can apply restrictions only at the level of file and directory names. If you want to filter results returned by *Dir* using other criteria, use *Where-Object* (Chapter 5).

The next example retrieves the biggest memory hogs in your user profile, specifically files that are at least 100 MB large:

```
Dir $home -recurse | Where-Object { $_.length -gt 100MB }
```

If you want to know just how many items *Dir* found, instruct *Dir* to retrieve its result as an array and set its *Count* property. The next instruction will tell you how many images are stored in your user profile (an operation that can take a long time):

```
@(Dir $home -recurse -include *.bmp,*.png,*.jpg, *.gif).Count
6386
```

Getting File and Directory Contents

You can use *Dir* to directly access individual files because *Dir* returns the contents of a directory in the form of file and directory objects. This enables you to obtain the *FileInfo* object of each file:

```
$file = Dir c:\autoexec.bat
$file | Format-List *

  PSPath             : Microsoft.PowerShell.Core\FileSystem::C:\autoexec.bat
  PSParentPath       : Microsoft.PowerShell.Core\FileSystem::C:\
  PSChildName        : autoexec.bat
  PSDrive            : C
  PSProvider         : Microsoft.PowerShell.Core\FileSystem
```

```
    PSIsContainer     : False
    Mode              : -a---
    Name              : autoexec.bat
    Length            : 24
    DirectoryName     : C:\: C:\
    IsReadOnly        : False
    Exists            : True
    FullName          : C:\autoexec.bat
    Extension         : .bat
    CreationTime      : 11.02.2006 11:23:09
    CreationTimeUtc   : 11.02.2006 10:23:09
    LastAccessTime    : 11.02.2006 11:23:09
    LastAccessTimeUtc : 11.02.2006 10:23:09
    LastWriteTime     : 09.18.2006 23:43:36
    LastWriteTimeUtc  : 09.18.2006 21:43:36
    Attributes        : Archive
```

This is how you could read the properties of single files as well as modify them if their properties allow modification:

```
  $file.Attributes

    Archive

  $file.Mode

    -a---
```

Get-Item uses another approach to access the file object. All three commands return the same result, which is the file object of the specified file.

```
  $file = Dir c:\autoexec.bat
  $file = Get-Childitem c:\autoexec.bat
  $file = Get-Item c:\autoexec.bat
```

However, *Get-Childitem* and *Get-Item* act very differently when accessing directories instead of files:

```
  # Dir or Get-Childitem retrieve the CONTENTS of a directory:
  $directory = Dir c:\windows
  $directory = Get-Childitem c:\windows
  $directory


    Directory: Microsoft.PowerShell.Core\FileSystem::C:\windows
    Mode                LastWriteTime     Length Name
    ----                -------------     ------ ----
    d----         11.02.2006     13:35            addins
    d----         10.11.2007     03:18            AppPatch
    d-r-s         08.31.2007     13:42            assembly
    (...)
```

```
# Get-Item retrieves the directory object itself:
$directory = Get-Item c:\windows
$directory


  Directory: Microsoft.PowerShell.Core\FileSystem::C:\
  Mode                LastWriteTime     Length Name
  ----                -------------     ------ ----
  d----         11.10.2007     03:07            windows

$directory | Format-List *

  PSPath            : Microsoft.PowerShell.Core\FileSystem::C:\windows
  PSParentPath      : Microsoft.PowerShell.Core\FileSystem::C:\
  PSChildName       : windows
  PSDrive           : C
  PSProvider        : Microsoft.PowerShell.Core\FileSystem
  PSIsContainer     : True
  Mode              : d----
  Name              : windows
  Parent            :
  Exists            : True
  Root              : C:\
  FullName          : C:\windows
  Extension         :
  CreationTime      : 02.11.2006 12:18:34
  CreationTimeUtc   : 02.11.2006 11:18:34
  LastAccessTime    : 11.10.2007 03:07:30
  LastAccessTimeUtc : 11.10.2007 01:07:30
  LastWriteTime     : 11.10.2007 03:07:30
  LastWriteTimeUtc  : 11.10.2007 01:07:30
  Attributes        : 65552
```

Passing Files to Cmdlets, Functions, or Scripts

Because *Dir* returns individual file and directory objects in its result, *Dir* can pass these objects directly to other cmdlets or to your own functions and scripts. This makes *Dir* an important selection command, which you can very conveniently use to recursively find all files having the type you're looking for on the entire hard disk drive or even on several drives.

To do so, process the result of *Dir* in the pipeline either by using *Where-Object* and then *ForEach-Object* (Chapter 5), or write your own pipeline filter (Chapter 9).

tip You can also combine the results of several separate *Dir* commands. In the following example, two separate *Dir* commands generate two separate file listings, which PowerShell combines into a total list and sends on for further processing in the pipeline. The example takes all the DLL files from the Windows system directory and all program installation directories, and then returns a list with the name, version, and description of DLL files:

```
$list1 = Dir $env:windir\system32\*.dll
$list2 = Dir $env:programfiles -recurse -filter *.dll
$totallist = $list1 + $list2
$totallist | ForEach-Object {
  $info =
[system.diagnostics.fileversioninfo]::GetVersionInfo($_.FullName);
  "{0,-30} {1,15} {2,-20}" -f $_.Name, `
    $info.ProductVersion, $info.FileDescription
}

  aaclient.dll           6.0.6000.16386 Anywhere access client
  accessibilitycpl.dll   6.0.6000.16386 Ease of access control panel
  acctres.dll            6.0.6000.16386 Microsoft Internet Account...
  acledit.dll            6.0.6000.16386 Access Control List Editor
  aclui.dll              6.0.6000.16386 Security Descriptor Editor
  (...)
```

Because *Dir* retrieves directories as well as files, it can sometimes be important to limit the result of *Dir* only to files or only to directories. There are several ways to do this. You can either validate the attribute of the returned object, the PowerShell *PSIsContainer* property, or the object type:

```
# List directories only::
Dir | Where-Object { $_ -is [System.IO.DirectoryInfo] }
Dir | Where-Object { $_.PSIsContainer }
Dir | Where-Object { $_.Mode.Substring(0,1) -eq "d" }
# List files only:
Dir | Where-Object { $_ -is [System.IO.FileInfo] }
Dir | Where-Object { $_.PSIsContainer -eq $false}
Dir | Where-Object { $_.Mode.Substring(0,1) -ne "d" }
```

The first variant (controlling object types) is the fastest by far while the latter (text comparison) is more complex and slower as a result of it complexity.

Where-Object can filter files according to other criteron as well.

For example, use the following pipeline filter if you'd like to locate only files that were created after May 12, 2007:

```
Dir | Where-Object { $_.CreationTime -gt [datetime]::Parse("May 12, 2007") }
```

You can use relative data if all you want to see are files that have been changed in the last two weeks:

```
Dir | Where-Object { $_.CreationTime -gt (Get-Date).AddDays(-14) }
```

Navigating the File System

Unless you changed your prompt in the way described in Chapter 9, the current directory in which you are working inside the PowerShell console is named at the command line prompt. You can find out what the current directory is by using *Get-Location*:

```
Get-Location

  Path
  ----
  C:\Users\Tobias Weltner\Sources
```

If you want to navigate to another location in the file system, use *Set-Location* or the *Cd* alias:

```
# One directory higher (relative):
Cd ..
# In the parent directory of the current drive (relative):
Cd \
# In a specified directory (absolute):
Cd c:\windows
# Take directory name from environment variable (absolute):
Cd $env:windir
# Take directory name from variable (absolute):
Cd $home
```

Relative and Absolute Paths

Path specifications can be either relative or absolute. In the last example you used both types.

Relative path specifications depend on the current directory, and the *.\test.txt* specification always refers to the *test.txt* file in the current directory while *..\test.txt* refers to the *test.txt* file in the parent directory. Relative path specifications are useful, for example, if you want to use library scripts that are located in the same directory as your work script. Your work script will then be able to locate library scripts under relative paths—no matter what the directory is called. Absolute paths are always unique and are independent of your current directory.

Character	**Meaning**	**Example**	**Result**
.	Current directory	*ii .*	Opens the current directory in Windows Explorer
..	Parent directory	*Cd ..*	Changes to the parent directory
\	Root	*Cd *	Changes to the topmost directory of a

	directory		drive
~	Home directory	*Cd ~*	Changes to the directory that PowerShell initially creates automatically

Table 15.2: Important special characters used for relative path specifications

Converting Relative Paths into Absolute Paths

Whenever you use relative paths, PowerShell must convert these relative paths into absolute paths. That occurs automatically when you invoke a file or a command using relative paths. You can resolve them yourself by using *Resolve-Path*.

```
Resolve-Path .\test.txt

  Path
  ----
  C:\Users\Tobias Weltner\test.txt
```

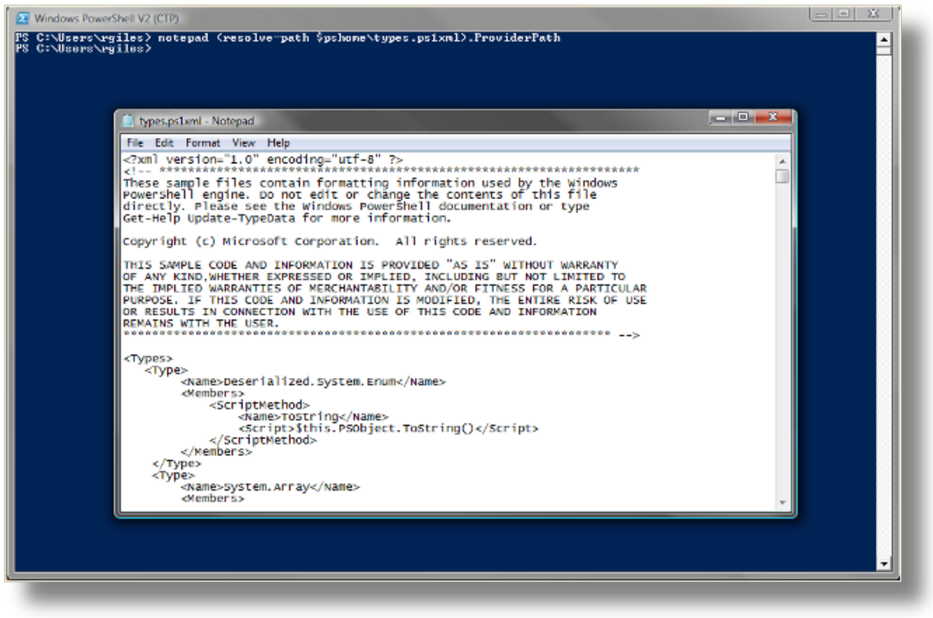
Resolve-Path, however, only works for files that actually exist. If there is no file in your current directory that's called *test.txt*, *Resolve-Path* will report an error.

Resolve-Path can have more than one result if the path that you specify includes wildcard characters. The following invocation will retrieve the names of all the *ps1xml* files in the PowerShell home directory:

```
Resolve-Path $pshome\*.ps1xml

  Path
  ----
  C:\Windows\System32\WindowsPowerShell\v1.0\Certificate.format.ps1xml
  C:\Windows\System32\WindowsPowerShell\v1.0\DotNetTypes.format.ps1xml
  C:\Windows\System32\WindowsPowerShell\v1.0\FileSystem.format.ps1xml
  C:\Windows\System32\WindowsPowerShell\v1.0\Help.format.ps1xml
  C:\Windows\System32\WindowsPowerShell\v1.0\PowerShellCore.format.ps1xml
  C:\Windows\System32\WindowsPowerShell\v1.0\PowerShellTrace.format.ps1xml
  C:\Windows\System32\WindowsPowerShell\v1.0\Registry.format.ps1xml
  C:\Windows\System32\WindowsPowerShell\v1.0\types.ps1xml
```

Like *Dir*, *Resolve-Path* can act as a selection filter for a downstream function. The following example shows opening a file in Notepad for processing. The command calls Notepad to open a file by using *Resolve-Path*.



```
PS C:\Users\rgiles> notepad (resolve-path $pshome\types.ps1xml).ProviderPath
PS C:\Users\rgiles>
```

```
<?xml version="1.0" encoding="utf-8" ?>
<!-- *******************************************************************
These sample files contain formatting information used by the Windows
PowerShell engine. Do not edit or change the contents of this file
directly. Please see the Windows PowerShell documentation or type
Get-Help Update-TypeData for more information.

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OF ANY KIND,WHETHER EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED TO
THE IMPLIED WARRANTIES OF MERCHANTABILITY AND/OR FITNESS FOR A PARTICULAR
PURPOSE. IF THIS CODE AND INFORMATION IS MODIFIED, THE ENTIRE RISK OF USE
OR RESULTS IN CONNECTION WITH THE USE OF THIS CODE AND INFORMATION
REMAINS WITH THE USER.
******************************************************************** -->

<Types>
   <Type>
        <Name>Deserialized.System.Enum</Name>
        <Members>
            <ScriptMethod>
                <Name>ToString</Name>
                <Script>$this.PSObject.ToString()</Script>
            </ScriptMethod>
        </Members>
    </Type>
    <Type>
        <Name>System.Array</Name>
        <Members>
```

Figure 15.1: Using Resolve-Path to select several files and opening them by querying

If there are no files at all that conform to the criterion, *Resolve-Path* will throw an error, which will be noted in the *$?* variable (Chapter 11). The expression *!$?* is always satisfied when an error occurs, and in such a case the function reports that no file was found.

The result is an array if *Resolve-Path* finds more than one file. In this case, the function lists the files that were found so not too many files will be unexpectedly opened in the event of a faulty entry. The function uses the internal PowerShell function *PromptForChoice()* that we saw in Chapter 6 to request the user for confirmation.

The *Call* operator we saw in Chapter 12 launches the file(s). Of course, this will only work if an application is allocated to the respective file type.

```
function edit-file([string]$path=$(Throw "Specify a relative path!"))
{
  # Resolve relative path and suppress error:
  $files = Resolve-Path $path -ea SilentlyContinue
  # Verify whether an error was generated:
  if (!$?)
  {
    # If yes, no file met the criterion, give notification and stop:
    "No file met your criterion."; break
  }
  # If several files are found, $files is an array:
  if ($files -is [array])
  {
    # In this case, list all found files:
    Write-Host -foregroundColor "Red" -backgroundColor "White" `
      "Do you want to open these files?"
    foreach ($file in $files)
    {
      "- " + $file.Path
    }
    # Then query whether all these files should really be opened:
    $yes = ([System.Management.Automation.Host.ChoiceDescription]"&yes")
    $no = ([System.Management.Automation.Host.ChoiceDescription]"&no")
    $choices = [System.Management.Automation.Host.ChoiceDescription[]]($yes,$no)
    $result = $host.ui.PromptForChoice('Open files','Open these files?',$choices,1)
    # If yes, invoke all files with the "&" call operator:
    if ($result -eq 0)
    {
     foreach ($file in $files)
      {
        & $file
      }
    }
  }
  else
  {
    # If there is only a single file, this is directly located
    # in $files and can be started using "&":
    & $files
  }
}
```

Saving Directory Locations

The current directory where you are working can be "pushed" to the top of a list of locations, called a "stack," by using *Push-Location*. Each *Push-Location* adds a new directory to the top of the stack. Use *Pop-Location* to get it back again.

So, to perform a task that forces you to leave your current directory, first type *Push-Location* to store your current location. Then, you can complete your task and when ready, use *Pop-Location* to retrieve your stored location.

tip

Cd $home will always take you back to your home directory. Moreover, both *Push-Location* and *Pop-Location* support the *-stack* parameter. This enables you to create as many stacks as you want, such as one for each task. *Push-Location -stack job1* puts the current directory not on the standard stack, but on the stack called "job1"; you can use *Pop-Location -stack job1* to restore the initial directory from this stack.

Finding Special Directories

Windows uses a number of special directories which, depending on installation, may be found at different locations. The paths of the most important directories are located in the Windows environment variables so that PowerShell can clearly allocate these special directories. You can find many other special directories through the *Environment* class of the .NET framework.

Special directory	**Description**	**Access**
Application data	Application data locally stored on the machine	*$env:localappdata*
User profile	User directory	*$env:userprofile*
Data used in common	Directory for data used by all programs	*$env:commonprogramfiles*
Public directory	Common directory of all local users	*$env:public*
Program directory	Directory in which programs are installed	*$env:programfiles*
Roaming Profiles	Application data for roaming profiles	*$env:appdata*
Temporary files (private)	Directory for temporary files of the user	*$env:tmp*
Temporary files	Directory for temporary files	*$env:temp*
Windows directory	Directory in which Windows is installed	*$env:windir*

Table 15.3: Important Windows directories that are stored in environment variables

Environment variables return only a few, and by far not all, of the paths of special directories. For example, if you'd like to put a file directly on a user's Desktop, you'll need the path to the Desktop that the environment variables can't retrieve for you. However, The *GetFolderPath()* method of the environment class of the .NET framework (Chapter 6) can do that. The following shows how you could put a link on the Desktop.

```
[Environment]::GetFolderPath("Desktop")
C:\Users\Tobias Weltner\Desktop
# Put a link on the Desktop:
$path = [Environment]::GetFolderPath("Desktop") + "\EditorStart.lnk"
$comobject = New-Object -comObject WScript.Shell
$link = $comobject.CreateShortcut($path)
$link.targetpath = "notepad.exe"
$link.IconLocation = "notepad.exe,0"
$link.Save()
```

The types of directories that *GetFolderPath()* can find are noted in the *SpecialFolder* enumeration. You should use the following line to view its contents:

```
[System.Environment+SpecialFolder] | Get-Member -static -memberType Property

     TypeName: System.Environment+SpecialFolder
  Name                  MemberType Definition
  ----                  ---------- ----------
  ApplicationData       Property   static System.Environment+SpecialFolder
  ApplicationData {get;}
  CommonApplicationData Property   static System.Environment+SpecialFolder
  CommonApplicationData ...
  CommonProgramFiles    Property   static System.Environment+SpecialFolder
  CommonProgramFiles {get;}
  Cookies               Property   static System.Environment+SpecialFolder Cookies
  {get;}
  Desktop               Property   static System.Environment+SpecialFolder Desktop
  {get;}
  DesktopDirectory      Property   static System.Environment+SpecialFolder
  DesktopDirectory {get;}
  Favorites             Property   static System.Environment+SpecialFolder
  Favorites {get;}
  History               Property   static System.Environment+SpecialFolder History
  {get;}
  InternetCache         Property   static System.Environment+SpecialFolder
  InternetCache {get;}
  LocalApplicationData  Property   static System.Environment+SpecialFolder
  LocalApplicationData {...
  MyComputer            Property   static System.Environment+SpecialFolder
  MyComputer {get;}
  MyDocuments           Property   static System.Environment+SpecialFolder
  MyDocuments {get;}
  MyMusic               Property   static System.Environment+SpecialFolder MyMusic
  {get;}
  MyPictures            Property   static System.Environment+SpecialFolder
  MyPictures {get;}
  Personal              Property   static System.Environment+SpecialFolder Personal
  {get;}
  ProgramFiles          Property   static System.Environment+SpecialFolder
  ProgramFiles {get;}
  Programs              Property   static System.Environment+SpecialFolder Programs
  {get;}
  Recent                  Property   static System.Environment+SpecialFolder Recent
  {get;}
  SendTo                  Property   static System.Environment+SpecialFolder SendTo
  {get;}
  StartMenu               Property   static System.Environment+SpecialFolder
  StartMenu {get;}
  Startup                 Property   static System.Environment+SpecialFolder Startup
  {get;}
  System                  Property   static System.Environment+SpecialFolder System
  {get;}
  Templates               Property   static System.Environment+SpecialFolder
  Templates {get;}
```

If you want an overview of all the directories that *GetFolderPath()* can locate, you can retrieve that as follows:

```
[System.Environment+SpecialFolder] |
Get-Member -static -memberType Property |
ForEach-Object { "{0,-25}= {1}" -f $_.name, `
  [Environment]::GetFolderPath($_.Name) }

  ApplicationData          = C:\Users\Tobias Weltner\AppData\Roaming
  CommonApplicationData    = C:\ProgramData
  CommonProgramFiles       = C:\Program Files\Common Files
  Cookies                  = C:\Users\Tobias
  Weltner\AppData\Roaming\Microsoft\Windows\Cookies
  Desktop                  = C:\Users\Tobias Weltner\Desktop
  DesktopDirectory         = C:\Users\Tobias Weltner\Desktop
  Favorites                = C:\Users\Tobias Weltner\Favorites
  History                  = C:\Users\Tobias
  Weltner\AppData\Local\Microsoft\Windows\History
  InternetCache            = C:\Users\Tobias
  Weltner\AppData\Local\Microsoft\Windows\Temporary Internet Files
  LocalApplicationData     = C:\Users\Tobias Weltner\AppData\Local
  MyComputer               =
  MyDocuments              = C:\Users\Tobias Weltner\Documents
  MyMusic                  = C:\Users\Tobias Weltner\Music
  MyPictures               = C:\Users\Tobias Weltner\Pictures
  Personal                 = C:\Users\Tobias Weltner\Documents
  ProgramFiles             = C:\Program Files
  Programs                 = C:\Users\Tobias
  Weltner\AppData\Roaming\Microsoft\Windows\Start Menu\Programs
  Recent                   = C:\Users\Tobias
  Weltner\AppData\Roaming\Microsoft\Windows\Recent
  SendTo                   = C:\Users\Tobias
  Weltner\AppData\Roaming\Microsoft\Windows\SendTo
  StartMenu                = C:\Users\Tobias
  Weltner\AppData\Roaming\Microsoft\Windows\Start Menu
  Startup                  = C:\Users\Tobias
  Weltner\AppData\Roaming\Microsoft\Windows\
                             Start Menu\Programs\Startup
  System                   = C:\Windows\system32
```

```
    Templates                   = C:\Users\Tobias
    Weltner\AppData\Roaming\Microsoft\Windows\Templates
```

Constructing Paths

Path names consist of text so you can construct them however you like. You saw above how you can construct the path of a file that is intended to be on a user's Desktop:

```
$path = [Environment]::GetFolderPath("Desktop") + "\file.txt"
$path
C:\Users\Tobias Weltner\Desktop\file.txt
```

Be absolutely sure that you put the right number of backward slashes in your path. That's why a backward slash was specified in front of the file name in the last example. A more reliable way would be to put together paths using *Join-Path* or the methods of the *Path* .NET class:

```
$path = Join-Path ([Environment]::GetFolderPath("Desktop"))  "test.txt"
$path

  C:\Users\Tobias Weltner\Desktop\test.txt

$path = [System.IO.Path]::Combine([Environment]::`
GetFolderPath("Desktop"), "test.txt")
$path

  C:\Users\Tobias Weltner\Desktop\test.txt
```

The *Path* class includes a number of additionally useful methods that you can use to put together paths or extract information from paths. Just insert *[System.IO.Path]::* in front of the methods listed in Table 15.4, for example:

```
[System.IO.Path]::ChangeExtension("test.txt", "ps1")

  test.ps1
```

Method	**Description**	**Example**
ChangeExtension()	Changes the file extension	*ChangeExtension("test.txt", "ps1")*
Combine()	Combines path strings; corresponds to *Join-Path*	*Combine("C:\test", "test.txt")*
GetDirectoryName()	Returns the	*GetDirectoryName("c:\test\file.*

	directory; corresponds to *Split-Path -parent*	*txt")*
GetExtension()	Returns the file extension	*GetExtension("c:\test\file.txt")*
GetFileName()	Returns the file name; corresponds to *Split-Path -leaf*	*GetFileName("c:\test\file.txt")*
GetFileNameWithoutExtension()	Returns the file name without the file extension	*GetFileNameWithoutExtension("c:\test\file.txt")*
GetFullPath()	Returns the absolute path	*GetFullPath(".\test.txt")*
GetInvalidFileNameChars()	Lists all characters that are not allowed in a file name	*GetInvalidFileNameChars()*
GetInvalidPathChars()	Lists all characters that are not allowed in a path	*GetInvalidPathChars()*
GetPathRoot()	Gets the root directory; corresponds to *Split-Path -qualifier*	*GetPathRoot("c:\test\file.txt")*
GetRandomFileName()	Returns a random file name	*GetRandomFileName()*
GetTempFileName()	Returns a temporary file	*GetTempFileName()*

	name in the *Temp* directory	
GetTempPath()	Returns the path of the directory for temporary files	*GetTempPath()*
HasExtension()	*True*, if the path includes a file extension	*HasExtension("c:\test\file.txt")*
IsPathRooted()	*True*, if the path is absolute; corresponds to *Split-Path -isAbsolute*	*IsPathRooted("c:\test\file.txt")*

Table 15.4: Methods for constructing paths

Working with Files and Directories

The cmdlets *Get-ChildItem* and *Get-Item* can get you file and directory items that already exist. You can also create your own new files and directories, rename them, fill them with content, copy them, move them, and, of course, delete them.

Creating New Directories

The easiest way to create new directories is to use the *Md* function, which invokes the cmdlet *New-Item* internally and specifies as *-type* parameter the *Directory* value:

```
# "md" is the predefined function and creates new directories:
md Test1


  Directory: Microsoft.PowerShell.Core\FileSystem::C:\users\Tobias Weltner
  Mode                LastWriteTime     Length Name
  ----                -------------     ------ ----
  d----        12.10.2007     17:14            Test1

# "New-Item" can do that, too, but takes more effort:
New-Item Test2 -type Directory
```

```
    Directory: Microsoft.PowerShell.Core\FileSystem::C:\users\Tobias Weltner
    Mode                LastWriteTime     Length Name
    ----                -------------     ------ ----
    d----         12.10.2007     17:14            Test2
```

tip

You can also create several subdirectories in one step as PowerShell automatically creates all the directories that don't exist yet in the specified path:

```
md test\subdirectory\somethingelse
```

Three subdirectories will be created as long as the directories *Test* and *Subdirectory* are not in the current directory.

Creating New Files

You could also use *New-Item* to create new files, but they would be completely empty:

```
New-Item "new file.txt" -type File


    Directory: Microsoft.PowerShell.Core\FileSystem::C:\users\Tobias Weltner
    Mode                LastWriteTime     Length Name
    ----                -------------     ------ ----
    -a---         10.12.2007     17:16          0 new file.txt
```

Files are usually automatically created when you save data results because empty files are not particularly useful,. Redirection and the cmdlets *Out-File* and *Set-Content* can help you:

```
Dir > info1.txt
.\info1.txt
Dir | Out-File info2.txt
.\info2.txt
Dir | Set-Content info3.txt
.\info3.txt
Set-Content info4.txt (Get-Date)
.\info4.txt
```

As it turns out, redirection and *Out-File* are very similar in operation: when PowerShell converts pipeline results, file contents look just like they would if you output the information in the console. *Set-Content* works differently as it only returns directory listing names because when you use *Set-Content* PowerShell doesn't turn objects into text automatically. Instead, *Set-Content* takes out a standard property from an object. In this case, the property is *Name*.

Normally, you would use *Set-Content* to write any text to a file. This last line shows how you could write a date to a file. For example, if you manually convert the pipeline result by using *ConvertTo-HTML*, *Out-File* and *Set-Content* will behave alike.

```
Dir | ConvertTo-HTML | Out-File report1.htm
.\report1.htm
Dir | ConvertTo-HTML | Set-Content report2.htm
.\report2.htm
```

tip

If you want to determine which object properties are displayed on a HTML page, use *Select-Object*, which was discussed in Chapter 5, to filter out the properties before conversion into HTML:

```
Dir | Select-Object name, length, LastWriteTime |
  ConvertTo-HTML | Out-File report.htm
.\report.htm
```

During redirection, the encoding of the console is used automatically to specify how special characters will be displayed in text. You can manually set encoding for *Out-File*.by using the *-encoding* parameter.

If you prefer to export the result as a comma-separated list, use the *Export-Csv* cmdlet instead of *Out-File.*

You can use either double redirection or *Add-Content* if you want to attach information to a text file:

```
Set-Content info.txt "First line"
"Second line" >> info.txt
Add-Content info.txt "Third line"
Get-Content info.txt

  First Line
  S e c o n d   L i n e
  Third line
```

The result may surprise you: the double redirection arrow worked, but text was displayed in spaced characters. The redirection operations basically use the console encoding , and this can lead to unexpected results if you happen to mix together the ANSI and Unicode character sets. Instead, use the cmdlets *Set-Content*, *Add-Content*, and *Out-File* without the redirections to avoid this risk. All three commands support the *-encoding* parameter, which you can use to select a character set.

Creating New Drives

It may surprise you that PowerShell allows you to create new drives. You're not limited to network drives only. You can also use drives as convenient shortcuts to other important locations in your file system and even beyond your file system.

Use *New-PSDrive* to create new drives. To set up a network drive, proceed as follows:

```
New-PSDrive -name network -psProvider FileSystem -root \\127.0.0.1\c$
```

```
    Name        Provider      Root
    ----        --------      ----
    network   FileSystem    \\127.0.0.1\c$
```

You can now access the network drive through the new virtual drive *network:* like this:

```
Dir network:
```

It's also easy to create convenient shortcuts in working locations. The next lines create the drives *desktop:* and *docs:*, which represent your Desktop and the Windows folder "My Documents":

```
New-PSDrive desktop FileSystem `
  ([Environment]::GetFolderPath("Desktop")) | out-null
New-PSDrive docs FileSystem `
  ([Environment]::GetFolderPath("MyDocuments")) | out-null
```

If you want to change to your Desktop later on, type:

```
Cd desktop:
```

Use *Remove-PSDrive* to remove a virtual drive you have created. You can't remove the drive if the drive is in use. Note that drive letters for New-*PSDrive* and *Remove-PSDrive* are specified without colons. On the other hand, when working with drives using customary file system commands, you do have to specify a colon.

```
Remove-PSDrive desktop
```

Reading the Contents of Text Files

Use *Get-Content* to retrieve the contents of a text-based file:

```
Get-Content $env:windir\windowsupdate.log
```

There is a shortcut that uses variable notation if you know the absolute path of the file:

```
${c:\windows\windowsupdate.log}
```

However, this notation usually isn't very practical because it doesn't allow any variables inside braces. In most cases, the file path can't be accessed through the same absolute path on all computer systems.

Get-Content reads the contents of a file line by line and passes on every line of text through the pipeline. So, you should add *Select-Object* if you wanted to read only the first 10 lines of a very long file:

```
Get-Content $env:windir\windowsupdate.log | Select-Object -first 10
```

Use *Select-String* to filter out the information you want from text files. The next line gets only those lines from the *windowsupdate.log* file that contain the phrase "added update":

```
Get-Content $env:windir\windowsupdate.log | Select-String "Added update"
```

Processing Comma-Separated Lists

You should use *Import-Csv* if you want to process information from comma-separated lists in PowerShell. For test purposes, first create a comma-separated list:

```
Set-Content user.txt "Username,Function,Passwordage"
Add-Content user.txt "Tobias,Normal,10"
Add-Content user.txt "Martina,Normal,15"
Add-Content user.txt "Cofi,Administrator,-1"
Get-Content user.txt

  Username,Function,Passwordage
  Tobias,Normal,10
  Martina,Normal,15
  Cofi,Administrator,-1
```

Now, use *Import-Csv* to input this comma-separated list:

```
Import-Csv user.txt

  Username                 Function            Passwordage
  -------------            -----            --------------
  Tobias                   Normal                       10
  Martina                  Normal                       15
  Cofi                     Administrator                -1
```

As you see, *Import-Csv* understands the comma format and displays the data column by column. Save yourself the substantial effort usually involved in parsing a comma-separated value file: *Import-Csv* will do it for you. The first line is read as a column heading. You could then conveniently use the data in the comma-separated value as an input, such as to create user accounts.

```
Import-Csv user.txt | ForEach-Object { $_.Username }
Tobias
Martina
Cofi
```

pro tip

Instead of a *ForEach-Object* loop, you can use a scriptblock in braces. The scriptblock is invoked inside the pipeline for every pipeline object and must be bound to a cmdlet parameter. In the following example, every user name in a comma-separated file is returned by the parameter *-InputObject* to echo and output.

```
Import-Csv user.txt | echo -InputObject {$_.Username }
```

Parsing Text Contents and Extracting Information

One frequent task is parsing raw data, such as log files , to get a structured readout of all the data. An example of such a log file is the *windowsupdate.log* file, which keeps a record of all Windows updates details (and which was misused as a guinea pig in previous examples). This file contains numerous data that at first glance seems scarcely readable. Initial analysis shows that the file stores information line by line and separates each piece of data by tab characters.

Regular expressions offer the easiest way to describe such a text format, which you already used in Chapter 13. You could use regular expressions to correctly describe the windowsupdate.log file contents as follows:

```
# The text pattern consists of six text arrays separated by tabs:
$pattern = "(.*)\t(.*)\t(.*)\t(.*)\t(.*)\t(.*)" (Enter)
# Inputting log:
$text = Get-Content $env:windir\windowsupdate.log (Enter)
# Take out any (here the 21st) line from the log and parse it:
$text[20] -match $pattern

  True

$matches

  Name   Value
  ----   -----
  6      * Added update {C14637DF-43D9-4201-9C0F-615D43943635}.101 to search result
  5      Agent
  4      2400
  3      1248
  2      09:18:02:087
  1      2007-05-19
  0      2007-05-19   09:18:02:087   1248   2400   Agent     * Added update...
```

$matches returns a hit here for every expression in parentheses so you could address each text array on every line through the index numbers. For example, if you are only interested in the date and the description in a line y, then format it as follows:

```
"On {0} this took place: {1}" -f $matches[1], $matches[6]

  On 2007-05-19 this took place:
  * Added update {C14637DF-43D9-4201-9C0F-615D43943635}.101
  to search result
```

Here, it is recommended that you give every subexpression its own name, which you can use later to query the result:

```
# This time, subexpressions have their own name:
$pattern = "(?<Datum>.*)\t(?<time>.*)\t(?<Code1>.*)" + `
  "\t(?<Code2>.*)\t(?<Program>.*)\t(?<Text>.*)"
# Inputting log:
$text = Get-Content $env:windir\windowsupdate.log
```

```
# Take out any (here the 21st) line from the log and parse it:
$text[20] -match $pattern

  True

# You can retrieve the information in $matches
# directly through the assigned name:
$matches.time + $matches.text

  09:18:02:087  * Added update {C14637DF-43D9-4201
  -9C0F-615D43943635}.101 to search result
```

You could now read in the entire log file, line by line, by using *Get-Content*, and then parse every line just the way it was above. This means that you could collect all the information you need, even from a gigantic log file, quickly and relatively efficiently. The next example does exactly that by listing only those lines in whose description is the phrase "woken up". This helps you find out whether a computer was woken up from the standby or sleep mode by automatic updates:

```
Get-Content $env:windir\windowsupdate.log |
ForEach-Object { if ($_ -match "woken up") { $_ } }

  2007-05-24  03:00:34:609  1276  1490  AU  The machine was woken up by
                                            Windows Update
  2007-05-24  03:00:34:609  1276  1490  AU  The system was woken up by
                                            Windows Update, but found to be
                                            running on battery power. Skip
                                            the forcedinstall.
  2007-06-28  03:00:11:563  1272  fe0   AU  The machine was woken up by
                                            Windows Update
```

If the loop is successful, it will output the entire line that was stored in *$_*. You now know how you could use a further regular expression to split up this line into arrays to output from it only certain pieces of information.

However, there is a second, and a much more sophisticated, way to select individual text lines of the file: *Switch*. Merely tell this statement which file you want to examine and how the pattern looks that you're looking for. *Switch* will do the rest. The next statement gets all log entries showing installed automatic updates, and it does so considerably faster than if you had used *Get-Content* and *ForEach-Object*. Just remember that in regular expressions ".*" can represent any number of any characters.

```
Switch -regex -file $env:windir\wu1.log {
  'START.*Agent: Install.*AutomaticUpdates' { $_ }}

  2007-05-19      09:22:04:113    1248    1d0c    Agent   **START**
  Agent: Installing updates [CallerId = AutomaticUpdates]
  2007-05-24      22:31:51:046    1276    c38     Agent   **START**
  Agent: Installing updates [CallerId = AutomaticUpdates]
  2007-06-13      12:05:44:366    1252    228c    Agent   **START**
  Agent: Installing updates [CallerId = AutomaticUpdates]
  (...)
```

Just substitute "SMS" or "Defender" for "automatic updates" in your regular expression if you'd like to find out when other updating programs, such as *SMS* or *Defender*, have installed updates. In fact, *Switch* can look for more than one pattern, and depending on the pattern it finds, carry out the instructions in the braces that follow it. This means you need only a few lines of code to find out how many updates you received and from which service:

```
# Create new hash table for the results:
result = @{Defender=0; AutoUpdate=0; SMS=0}
# Parse update log and keep record of installations in hash table:
Switch -regex -file $env:windir\wu1.log
{
'START.*Agent: Install.*Defender' { $result.Defender += 1 };
'START.*Agent: Install.*AutomaticUpdates' { $result.AutoUpdate +=1 };
'START.*Agent: Install.*SMS' { $result.SMS += 1}
}
# Output result:
$result

  Name                           Value
  ----                           -----
  SMS                            0
  Defender                       1
  AutoUpdate                     8
```

Reading Binary Contents

Not all files contain text. Sometimes, it's necessary to read information from binary files. Normally, the visible file extension of a file plays the greatest role because it determines which program Windows uses to open the file. However, in many binary files, a header is also tightly integrated with the file. The header includes an internal type designation that provides information about what sort of file it is. *Get-Content* can obtain these "magic bytes" with the help of the parameters *-readCount* and *-totalCount*. The parameter *-readCount* indicates how many bytes are read in one step; *-totalCount* determines the number of bytes that you want to read from the file. In this case, the bytes you're looking for are the first four bytes of the file:

```
function Get-MagicNumber ($path)
{
    Resolve-Path $path | ForEach-Object {
      $magicnumber = Get-Content -encoding byte $_ -read 4 -total 4
      $hex1 = ("{0:x}" -f ($magicnumber[0] * `
        256 + $magicnumber[1])).PadLeft(4, "0")
      $hex2 = ("{0:x}" -f ($magicnumber[2] * `
        256 + $magicnumber[3])).PadLeft(4, "0")
      [string] $chars = $magicnumber| %{ if ([char]::IsLetterOrDigit($_))
      { [char] $_ } else { "." }}
      "{0} {1} '{2}'" -f $hex1, $hex2, $chars
    }
}
Get-MagicNumber "$env:windir\explorer.exe"
4d5a 9000 'M Z . .'
```

The first four bytes of the Explorer are 4d, 5a, 90, and 00—or are given as the text *MZ*. Those are the initials of Mark Zbikowski, one of the developers of Microsoft DOS. The tag MZ represents executable programs. The tag looks different for graphics:

```
Get-MagicNumber "$env:windir\web\wallpaper\*.*"
ffd8 ffe0 'Ã¿ Ã˜ Ã¿ Ã  '
ffd8 ffe0 'Ã¿ Ã˜ Ã¿ Ã  '
ffd8 ffe0 'Ã¿ Ã˜ Ã¿ Ã  '
ffd8 ffe0 'Ã¿ Ã˜ Ã¿ Ã  '
ffd8 ffe0 'Ã¿ Ã˜ Ã¿ Ã  '
ffd8 ffe0 'Ã¿ Ã˜ Ã¿ Ã  '
(...)
```

pro tip

You've seen that *Get-Content* can also read binary files, one byte at a time. Specify in the *-readCount* parameter how many bytes should be read for each step. *-totalCount* determines the total number of bytes that you want to read. If you assign the parameter *-1*, the file will be read to the end. You can assemble a little viewer for yourself that outputs data in hexadecimal form because binary data doesn't particularly look good as text:

```
function Get-HexDump($path,$width=10, $bytes=-1)
{
    $OFS=""
    Get-Content -encoding byte $path -readCount $width `
        -totalCount $bytes |  ForEach-Object {
        $characters = $_
        if (($characters -eq 0).count -ne $width)
        {
            $hex = $characters | ForEach-Object {
                " " + ("{0:x}" -f $_).PadLeft(2,"0")}
            $char = $characters | ForEach-Object {
                if ([char]::IsLetterOrDigit($_))
                    { [char] $_ } else { "." }}
            "$hex $char"
        }
    }
}
Get-HexDump $env:windir\explorer.exe -width 15 -bytes 150


  4d 5a 90 00 03 00 00 00 04 00 00 00 ff ff 00 MZ..........ÿÿ.
   00 b8 00 00 00 00 00 00 40 00 00 00 00 00 ...............
   d8 00 00 00 0e 1f ba 0e 00 b4 09 Cd 21 b8 01 Ø.....º....Í...
   4c Cd 21 54 68 69 73 20 70 72 6f 67 72 61 6d LÍ.This.program
   20 63 61 6e 6e 6f 74 20 62 65 20 72 75 6e 20 .cannot.be.run.
   69 6e 20 44 4f 53 20 6d 6f 64 65 2e 0d 0d 0a in.DOS.mode....
   24 00 00 00 00 00 00 00 ec 53 20 a3 a8 32 4e ........ìS...2N
   f0 a8 32 4e f0 a8 32 4e f0 8f f4 33 f0 ae 32 ð.2Nð.2Nð.ô3ð.2
```

Moving and Copying Files and Directories

Move-Item and *Copy-Item* perform moving and copying operations. You may use wildcard characters with them. The following statement copies all PowerShell scripts from your home directory to the Desktop:

```
Copy-Item $home\*.ps1 ([Environment]::GetFolderPath("Desktop"))
```

However, only those scripts were copied that are directly available in the *$home* directory. While *Copy-Item* is familiar with the *-recurse* parameter, the parameter, similar to *Dir*, won't work if your initial path no longer contains any directories.

```
Copy-Item -recurse $home\*.ps1 ([Environment]::GetFolderPath("Desktop"))
```

Use *Dir* to copy all the *PowerShell* scripts to your Desktop anyway. Let it find the PowerShell scripts for you, and then pass the result on to *Copy-Item*:

```
Dir -filter *.ps1 -recurse | ForEach-Object {
  Copy-Item $_.FullName ([Environment]::GetFolderPath("Desktop")) }
```

tip

You might be tempted to reduce this line because every file object has an integrated *CopyTo()* method:

```
Dir -filter *.ps1 -recurse | ForEach-Object {
$_.CopyTo([Environment]::GetFolderPath("Desktop")) }
```

But the result would be an error. *CopyTo()* is a low-level function and needs the destination path for the file that is to be copied. Because you just want to copy all the files to the Desktop, you specified the path of the destination directory. *CopyTo()* will try to copy the file under precisely this name, which naturally cannot succeed because the Desktop already exists as a directory. *Copy-Item* is smarter: the file will be copied to this directory if the destination is a directory.

Because by now your Desktop is probably teeming with PowerShell scripts, it would be better to store them in their own subdirectory. You should create a new subdirectory on the Desktop, and move all your PowerShell scripts on the Desktop into this subdirectory:

```
$desktop = [Environment]::GetFolderPath("Desktop")
md ($desktop + "\PS Scripts")
Move-Item ($desktop + "\*.ps1") ($desktop + "\PS Scripts")
```

Your Desktop is now tidy again, and all your scripts are safely stored in a common directory on your Desktop.

Renaming Files and Directories

Use *Rename-Item* if you want to give a file or a directory another name. But be careful when you do this because Windows could be ruined if you rename system directories or files. Even if you rename the file extensions of files, you may not be able to open these files and display them properly any more.

```
Set-Content testfile.txt "Hello,this,is,an,enumeration"
# File is opened in editor:
.\testfile.txt
# File is opened in Excel:
Rename-Item testfile.txt testfile.csv
.\testfile.csv
```

Numerous Renames

Because *Rename-Item* can be used as a building block in the pipeline, it provides surprisingly simple solutions to complex tasks. For example, if you want to remove the term "x86" from a directory and all its subdirectories, as well as all the included files, this instruction will suffice:

```
Dir | ForEach-Object {
  Rename-Item $_.Name $_.Name.replace("-x86", "") }
```

However, this command will now actually attempt to rename all the files and directories, even if the term you're looking for isn't even in the file name. That generates errors and is very time-consuming. To greatly speed things up, sort out in advance all the files and directories that are in question by using Where-Object, which can increase speed by a factor of 50:

```
Dir | Where-Object { $_.Name -contains "-x86" } | ForEach-Object {
  Rename-Item $_.Name $_.Name.replace("-x86", "") }
```

Changing File Extensions

If you want to change the file extension, be aware first of the consequences: the file will subsequently be recognized as another file type, and possibly be opened by the wrong application program or perhaps not be able to be opened by any application at all. The next instruction renames all PowerShell scripts in the current directory and changes the file extension from ".ps1" to ".bak".

```
Dir *.ps1 | ForEach-Object { Rename-Item $_.Name `
  ([System.IO.Path]::GetFileNameWithoutExtension($_.FullName) + `
  ".bak") -whatIf }

  What if: Performing operation "Rename file" on Target
  "Element: C:\Users\Tobias Weltner\tabexpansion.ps1
  Destination: C:\Users\Tobias Weltner\tabexpansion.bak".
```

Because of the *-whatIf* parameter, initially the statement only indicates which renaming operation you could carry out.

Sorting Out File Names

Data collections often grow over time. If you want to sort out a directory, you could give all the files it contains uniform names and sequential numbers, or you could synthesize file names from some specific properties of files. Remember that PowerShell script folder that we just created on your Desktop? Let's properly number the PowerShell scripts in the folder in sequence:

```
$directory = [Environment]::GetFolderPath("Desktop") + "\PS Scripts"
Dir $directory\*.ps1


  Directory: Microsoft.PowerShell.Core\FileSystem::C:\Users\Tobias Weltner\Desktop\
  PS Scripts
  Mode                LastWriteTime     Length Name
  ----                -------------     ------ ----
  -a---         02.08.2007     17:21        46 a.ps1
  -a---         02.08.2007     17:32       146 b.ps1
  -a---         20.06.2007     16:41       766 clearhost.ps1
  -a---         20.06.2007     14:47       768 clearhost2.PS1
  -a---         02.08.2007     18:51        46 d.PS1
  -a---         18.06.2007     13:32       869 findCommandName.ps1
  -a---         27.04.2007     23:39       200 getdlls.ps1
  -a---         10.05.2007     14:53      1138 installfont.ps1
  -a---         02.08.2007     18:53        15 k.PS1
  -a---         27.04.2007     13:19       264 myinvoke.ps1
  -a---         20.06.2007     12:08        27 junk.PS1
  -a---         21.06.2007     08:15      2742 prereqs.ps1
  -a---         27.06.2007     14:11       495 profile.ps1
  -a---         26.04.2007     21:59       250 progress.ps1
  -a---         15.06.2007     15:44      4366 tabexpansion.ps1
  -a---         08.06.2007     12:56       176 test - Copy (2).ps1
  -a---         08.06.2007     12:56       176 test - Copy (3).ps1
  -a---         08.06.2007     12:56       176 test - Copy (4).ps1
  -a---         08.06.2007     12:56       176 test - Copy (5).ps1
  -a---         08.06.2007     12:56       176 test - Copy.ps1
  -a---         08.06.2007     12:56       176 test.ps1
  -a---         27.04.2007     20:42       106 test2.ps1
  -a---         20.06.2007     14:42       766 Untitled.ps1

Dir $directory\*.ps1 | ForEach-Object {$x=0} {
  Rename-Item $_ ("Script " + $x + ".ps1"); $x++ } {"Finished!"}
Dir $directory\*.ps1


  Directory: Microsoft.PowerShell.Core\FileSystem::C:\Users\Tobias Weltner\Desktop\
  PS Scripts
  Mode                LastWriteTime     Length Name
  ----                -------------     ------ ----
  -a---         08.02.2007     17:21        46 Script 0.ps1
  -a---         08.02.2007     17:32       146 Script 1.ps1
  -a---         06.08.2007     12:56       176 Script 10.ps1
  -a---         06.08.2007     12:56       176 Script 11.ps1
```

```
    -a---         06.20.2007     16:41         766 Script 12.ps1
    -a---         06.08.2007     12:56         176 Script 13.ps1
    -a---         04.27.2007     20:42         106 Script 14.ps1
    -a---         06.20.2007     14:42         766 Script 15.ps1
    -a---         06.20.2007     14:47         768 Script 16.ps1
    -a---         08.02.2007     18:51          46 Script 17.ps1
    -a---         06.18.2007     13:32         869 Script 18.ps1
    -a---         04.27.2007     23:39         200 Script 19.ps1
    -a---         06.20.2007     12:08          27 Script 2.ps1
    -a---         05.10.2007     14:53        1138 Script 20.ps1
    -a---         02.08.2007     18:53          15 Script 21.ps1
    -a---         04.27.2007     13:19         264 Script 22.ps1
    -a---         06.21.2007     08:15        2742 Script 3.ps1
    -a---         06.27.2007     14:11         495 Script 4.ps1
    -a---         04.26.2007     21:59         250 Script 5.ps1
    -a---         06.15.2007     15:44        4366 Script .ps1
    -a---         08.06.2007     12:56         176 Script 7.ps1
    -a---         08.06.2007     12:56         176 Script 8.ps1
    -a---         08.06.2007     12:56         176 Script 9.ps1
```

Deleting Files and Directories

Use *Remove-Item* or the *Del* alias to remove files and directories, which deletes files and directories irrevocably. If a file is write-protected, you'll have to specify the -*force* parameter.

```
# Create an example file:
$file = New-Item testfile.txt -type file
# There is no write protection:
$file.isReadOnly

  False

# Activate write protection:
$file.isReadOnly = $true
$file.isReadOnly

  True

# Write-protected file may be deleted only by using the -Force parameter:
del testfile.txt

  Remove-Item : Cannot remove item C:\Users\Tobias Weltner\testfile.txt: Not enough
  permission to perform operation.
  At line:1 char:4
  + del  <<<< testfile.txt
  del testfile.txt -force
```

Deleting Directory Contents

Use wildcard characters if all you want to do is to delete the contents of a directory, but still keep the directory. The following line, for example, will delete the contents of the *Recent* directory, which corresponds to "My Recent Documents" on the start menu. Because deleting files and directories is not something to be taken lightly and can have serious consequences, you can just simulate their deletion first by using *-whatIf* to see what happens:

```
$recents =  [Environment]::GetFolderPath("Recent")
del $recents\*.* -whatIf
```

If you are convinced that your command is correct, and that it will delete the correct files, repeat the statement without *-whatIf*. On the other hand, if you're still unsure, you can also use *-confirm*, which makes every deletion contingent on your approval.

Deleting Directories and Their Contents

If a directory is deleted, its entire contents will be lost. PowerShell requests confirmation whenever you attempt to erase a directory along with its contents to prevent you from unintentionally destroying large quantities of data. Only the deletion of empty directories does not require confirmation:

```
# Create a test directory:
md testdirectory


  Directory: Microsoft.PowerShell.Core\FileSystem::C:\Users\Tobias Weltner\Sources\
  docs
  Mode                LastWriteTime     Length Name
  ----                -------------     ------ ----
  d----        13.10.2007     13:31            testdirectory

# Create a file in the directory:
Set-Content .\testdirectory\testfile.txt "Hello"
# Delete directory:
del testdirectory

  Confirm
  The item at "C:\Users\Tobias Weltner\Sources\docs\testdirectory" has children
  and the Recurse parameter was not specified. If you continue, all children
  will be removed with the item. Are you sure you want to continue?
  |Y| Yes  |A| Yes to All  |N| No  |L| No to All  |S| Suspend  |?| Help (default is
  "Y"):
```

But if you had specified the *-recurse* parameter, PowerShell would have deleted the directory, including its contents, immediately and without asking for confirmation:

```
del testdirectory -recurse
```

Managing Access Permissions

For NTFS drives, access permissions determine which users may access files and directories. For each file and directory, security data is laid down in what is known as a "security descriptor" (SD). The *security descriptor* determines whether security settings are valid only for the current directory or whether they can be passed on other files and directories. The real access permissions are on *access control lists* (ACL). An *access control entry* (ACE) for every single access permission is on the ACL.

note

File and directory access permissions are equivalent to complex electronic locks. If used properly, you can make them into an effective security system. However if improperly used, you can just as easily lock yourself out, lose access to important data, or damage the Windows operating system (when you unintentionally block access to key system directories). As owner of a file or directory, you always have the option of correcting permissions, and as an administrator, you can always assume ownership of a file or directory. But that's a back door you can't rely on: you should change permissions only when you are fully aware of what will be the consequences. It's better to experiment initially with test directories and files.

PowerShell uses the cmdlets *Get-Acl* und *Set-Acl* to manage permissions. In addition, traditionally proven commands like *cacls* are available to you in the PowerShell console. Often, they can modify access permissions more quickly than PowerShell cmdlets, particularly when you're working with very many files and directories. Since Windows Vista was released, *cacls* has been regarded as outdated. If possible, use its successor, *icacls*.

```
cacls /?

  NOTE: Cacls is now deprecated, please use Icacls.
   Displays or modifies access control lists (ACLs) of files
   CACLS Filename  [/T] [/M] [/L] [/S[:SDDL]] [/E] [/C]
                   [/G user:perm] [/R user [...]]
                   [/P user:perm [...]]
                   [/D user [...]]
     Filename      Displays ACLs.
     /T            Changes ACLs of specified files in
                   the current directory and all subdirectories.
     /L            Performs the action on a symbolic link versus its destination.
     /M            Changes ACLs of volumes mounted to a directory.
     /S            Displays the SDDL string for the DACL.
     /S:SDDL       Replaces the ACLs with those specified in the SDDL string
                   (not valid with /E, /G, /R, /P, or /D).
     /E            Edit ACL instead of replacing it.
     /C            Continue on access denied errors.
     /G user:perm  Grant specified user access permissions.
                   Perm can be:  R  Read
                                 W  Write
```

```
                              C   Change (write)
                              F   Full control
   /R user       Revoke specified user's access permissions (only valid with /E).
   /P user:perm  Replace specified user's access permissions
                 Perm can be:  N   None
                               R   Read
                               W   Write
                               C   Change (write)
                               F   Full control
    /D user      Deny specified user access.

Wildcards can be used to specify more than one file in a command.
You can specify more than one user in a command.
Abbreviations:
 CI - Container Inherit.
```

Checking Effective Security Settings

Effective security settings of directories and files are on the access control list, and PowerShell retrieves the contents of this list when you use *Get-Acl*. So, if you would like to find out who has access to a certain file or a certain directory, proceed as follows:

```
# list permissions for Windows directory:
Get-Acl $env:windir


     Directory: Microsoft.PowerShell.Core\FileSystem::C:\
 Path     Owner                       Access
 ----     -----                       ------
 Windows  NT SERVICE\TrustedInstaller  CREATOR OWNER Allow  268435...
```

Establishing the Identity of the Owner

The owner of a file or directory has special rights. For example, the owner can always get access and you can find the owner in the *Owner* property:

```
(Get-Acl $env:windir).Owner

NT SERVICE\TrustedInstaller
```

Listing Access Permissions

Actual access permissions—who may do what—are output in the *Access* property:

```
(Get-Acl $env:windir).Access | Format-Table -wrap

  FileSystem Access  IdentityReference IsInhe InheritanceFlags PropagationFlags
      Rights Control                   rited
             Type
```

```
    ---------- ------- ----------------- ------ ---------------- ----------------
     268435456 Allow   CREATOR OWNER     False ContainerInherit, InheritOnly
                                               ObjectInherit
     268435456 Allow   NT AUTHORITY\     False ContainerInherit, InheritOnly
                       SYSTEM                  ObjectInherit
  Modify, Sync Allow   NT AUTHORITY\     False None              None
       hronize         SYSTEM
     268435456 Allow   BUILTIN\Admi      False ContainerInherit, InheritOnly
                       nistrators              ObjectInherit
  Modify, Sync Allow   BUILTIN\Admi      False None              None
       hronize         nistrators
   -1610612736 Allow   BUILTIN\Users     False ContainerInherit, InheritOnly
                                               ObjectInherit
  ReadAndExecu Allow   BUILTIN\Users     False None              None
  te, Synchron
  ize
     268435456 Allow   NT SERVICE\Truste False ContainerInherit  InheritOnly
                       dInstaller
   FullControl Allow   NT SERVICE\Truste False None              None
                       dInstaller
```

The *IdentityReference* column of this overview tells you who has special permission; the *FileSystemRights* column also tell you the type of permission. The *AccessControlType* column is particularly important because if it shows *Deny* instead of *Allow,* you will know who is restricted and who has access.

Creating New Permissions

The object returned by *Get-Acl* contains a number of methods that you can use to modify permissions or assume ownership. If you'd like to set permissions yourself, you don't necessarily have to delve deeply into the world of security descriptors. Often, it suffices either to read the security descriptor of an existing file and to transfer it to another or to specify the security information in the form of a text in the special SDDL language.

Whether you want to modify the structure of the security descriptor yourself or acquire a complete security descriptor: use *Set-Acl* to assign the security descriptor to a new object.

tip

The below examples will acquaint you with all the usual procedures. Note two aspects: don't forget proven tools, like *cacls*, because you may be able to do your work more quickly with it than with PowerShell. Moreover, the *Get-Acl* and *Set-Acl* team work not only on the file level, but also everywhere where security descriptors control access, such as in the Windows registry (see next chapter).

"Cloning" Permissions

In a rudimentary case, you wouldn't create any new permissions but would "clone" permissions by transferring the access control list of an existing directory (or a file) to another. The advantage is that this enables you to use a graphic interface to set permissions, which are often complex.

note

Because the manual adjustment of security settings is a job for professionals, non-commercial Windows versions like *Windows XP Home* do not have this option. Nevertheless, you can use PowerShell to modify file and directory permissions used in these Windows versions as well.

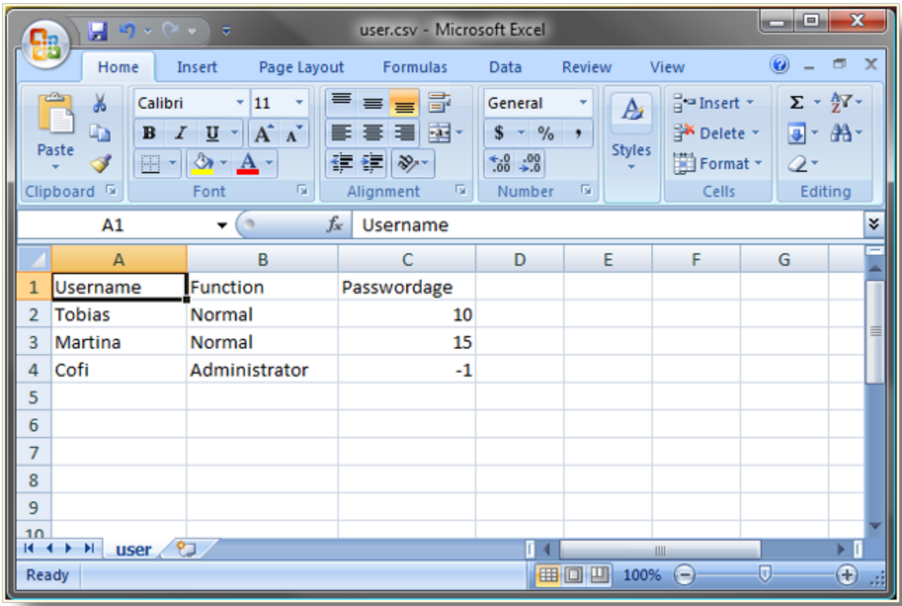
To begin, create two directories as a test:

```
md Prototype | out-null
md Protected | out-null
```

Now, open Explorer, and change the security settings of the *Prototype* directory.

```
explorer .
```

In Explorer, right-click the *Prototype* directory and select *Properties*. Then, click the *Security* tab.



A1 | Username

	A	B	C	D	E	F	G
1	Username	Function	Passwordage				
2	Tobias	Normal	10				
3	Martina	Normal	15				
4	Cofi	Administrator	-1				
5							
6							
7							
8							
9							
10							

Figure 15.2: Modifying security settings of the directory using a dialog box

Click *Modify* and add additional people to change the security settings of the test directory. Set permissions for the new persons in the lower area of the dialog box.

note

You may also deny users permission by putting a check mark after permission in the *Deny* column. You have to be very careful when doing this since restrictions always have priority over permissions. For example, if you were to grant yourself full access but deny access for the *Everyone* group, you would shut yourself out of your own system. You also belong to the *Everyone* group, and since restrictions have priority, the restrictions also apply to you—even though you granted yourself full access.

After you've changed permissions, take a look at the permissions of the second test directory, *Protected*, in Explorer. This directory is still assigned default permissions. In the next step, the new permissions of the *Prototype* directory will be transferred to the *Protected* directory:

```
$acl = Get-Acl Prototype
Set-Acl Protected $acl
```

note

You need special rights to set permissions. If you're operating PowerShell using the Windows Vista operating system and User Account Control is active, you won't have these permissions and you'll get an error message. Run PowerShell as administrator to obtain the permissions.

That's all there is to it. The *Protected* directory is now just as secure as the *Prototype* directory, and when you check their security settings in Explorer, you'll see that all their settings are identical.

Using SDDL to Set Permissions

The previous example was very simple because all you did was transfer the security settings of an existing directory to another. In your daily work, you'll always require a *Prototype* directory, and that's often unwanted. But you can also summarize the security settings of a security descriptor as text. Each security setting is defined in the special *Security Descriptor Description Language (SDDL)*. It enables you to read out the security information of the *Prototype* directory as text and use it later without having to resort to the *Prototype* directory.

Let's delete the old *Protected* test directory, and then save the security information of the *Prototype* directory in the SDDL:

```
Del Protected
$acl = Get-Acl Prototype
$sddl = $acl.Sddl
$sddl
```

```
O:S-1-5-21-3347592486-2700198336-2512522042-1000G:S-1-5-21-3347592486-
2700198336-2512522042-513D:AI(A;OICI;0x1200a9;;;WD)(A;OICI;FA;;;LA)(A;ID;
FA;;;S-1-5-21-3347592486-2700198336-2512522042-1000)(A;OICIIOID;GA;;;S-1-
5-21-3347592486-2700198336-2512522042-1000)(A;ID;FA;;;SY)(A;OICIIOID;GA;;
;SY)(A;ID;FA;;;BA)(A;OICIIOID;GA;;;BA)
```

You could now include the SDDL text in a second script and assign its security settings to any directory .

```
# Create new directory
Md Protected
# Security description in SDDL (one line):
$sddl = "O:S-1-5-21-3347592486-2700198336-2512522042-1000G:" + `
  "S-1-5-21-3347592486-2700198336-2512522042-513D:" + `
  "AI(A;OICI;0x1200a9;;;WD)(A;OICI;FA;;;LA)" + `
  "(A;ID;FA;;;S-1-5-21-3347592486-2700198336-2512522042-1000)" + `
  "(A;OICIIOID;GA;;;S-1-5-21-3347592486-2700198336-2512522042-1000)" + `
  "(A;ID;FA;;;SY)(A;OICIIOID;GA;;;SY)(A;ID;FA;;;BA)(A;OICIIOID;GA;;;BA)"
# Get security description of the directory:
$acl = Get-Acl Protected
# Replace security description with the SDDL definition:
$acl.SetSecurityDescriptorSddlForm($sddl)
# Write back modification
Set-Acl Protected $acl
```

note

Your second script is completely independent of your *Prototype* directory. What you've done is use the *Prototype* directory only temporarily to generate the SDDL definition of your security settings with the help of the user interface.

However, the SDDL cannot be simply transferred to other computers. If you take a second look, you'll see that each authorized person is not identified by name, but by a security identifier (SID). This SID differs from person to person so even if there were accounts on several computers that have the same name, they would be different accounts, in reality, with different SIDs. However inside a domain, the SIDs of user accounts is the same on all computers because the domain centrally manages them. As a result, the SDDL solution is ideal for domain-based company networks. Nevertheless, if you're working in a small peer-to-peer network, SDDL can be useful. You just have to use "copy & paste" to replace the SIDs of respective accounts. It would be even simpler, though, to use the commands *cacls* or *icacls* in peer-to-peer networks.

Manually Creating New Permissions

Permissions can also be created manually. The advantage is that you specify authorized users by name so that this approach would work on any computer in the same way—even if there is no central domain.

But note that this involves extra effort because then you would have to create the security descriptor entirely on your own. The next example will show you how to do this. However in practice, this procedure is usually too time-consuming. It's simpler in this case to use commands like *cacls* or *icacls*. Now, let's delete the *Protected* test directory again and create a new one so that the directory is again assigned default access rights:

```
Del Protected
Md Protected
```

Ultimately, this directory should have general read access permission for the *Everyone* group and full access to the *Administrator* account. To accomplish this, use *AddAccessRule()* to add two new access rules to the security descriptor:

```
$acl = Get-Acl Protected
# Add first rule:
$person = [System.Security.Principal.NTAccount]"Administrator"
$access = [System.Security.AccessControl.FileSystemRights]"FullControl"
$inheritance = [System.Security.AccessControl.InheritanceFlags] `
  "ObjectInherit,ContainerInherit"
$propagation = [System.Security.AccessControl.PropagationFlags]"None"
$type = [System.Security.AccessControl.AccessControlType]"Allow"
$rule = New-Object System.Security.AccessControl.FileSystemAccessRule( `
  $person,$access,$inheritance,$propagation,$type)
$acl.AddAccessRule($rule)
# Add second rule:
$person = [System.Security.Principal.NTAccount]"Everyone"
$access = [System.Security.AccessControl.FileSystemRights]"ReadAndExecute"
$inheritance = [System.Security.AccessControl.InheritanceFlags] `
  "ObjectInherit,ContainerInherit"
$propagation = [System.Security.AccessControl.PropagationFlags]"None"
$type = [System.Security.AccessControl.AccessControlType]"Allow"
$rule = New-Object System.Security.AccessControl.FileSystemAccessRule( `
  $person,$access,$inheritance,$propagation,$type)
$acl.AddAccessRule($rule)
# Write back changed permissions:
Set-Acl Protected $acl
```

Next, let's look at how each access rule is defined. Five details are required for each rule:

- **Person:** Here the person or the group is specified to which the rule is supposed to apply.
- **Access:** Here permissions are selected that the rule controls.
- **Inheritance:** Here the objects are selected to which the rule applies**.**The rule can, and normally also is, granted to child objects, so it applies automatically to files that are in a directory.
- **Propagation:** Determines whether permissions are passed to child objects (such as subdirectories and files). Normally, the setting is *None* and permissions are merely granted.
- **Type:** This enables you to set either a permission or restriction. If restriction, the permissions that were specified will expressly *not* be granted.

The next question is: which values are allowed for these specifications? The example shows that specifications are given in the form of special .NET objects (Chapter 6). You can list all the permitted values for access permissions by using the following trick:

```
[System.Enum]::GetNames([System.Security.AccessControl.FileSystemRights])

  ListDirectory
  ReadData
  WriteData
  CreateFiles
  CreateDirectories
  AppendData
  ReadExtendedAttributes
  WriteExtendedAttributes
  Traverse
  ExecuteFile
  DeleteSubdirectoriesAndFiles
  ReadAttributes
  WriteAttributes
  Write
  Delete
  ReadPermissions
  Read
  ReadAndExecute
  Modify
  ChangePermissions
  TakeOwnership
  Synchronize
  FullControl
```

You would actually have to combine the relevant values from the list if you want to set access permissions, such as like this:

```
$access = [System.Security.AccessControl.FileSystemRights]::Read `
  -bor [System.Security.AccessControl.FileSystemRights]::Write
$access

  131209
```

The result is a number, the bitmask for permissions to read and write. In the above example, you achieved the same result more easily because you are allowed to specify wanted items, even if they are comma-separated items and enclosed in brackets, after a .NET enumeration:

```
$access = [System.Security.AccessControl.FileSystemRights]"Read,Write"
$access

  Write, Read

[int]$access

  131209
```

Because you didn't carry out any binary *-bor* calculations here, the result is readable text. But in this case the bitmask is at work here, as the conversion to the *Integer* data type proves. You can find out what the underlying value of a setting is at any time like this:

```
[int][System.Security.AccessControl.InheritanceFlags] `
  "ObjectInherit,ContainerInherit"

  3
```

The significance of this for you is that you can now examine the permitted values for the other .NET enumerations and convert these into numbers. While it won't make your commands more readable, they will be shorter because the following lines do the same thing as the lines in the preceding example:

```
Del Protected
Md Protected
$acl = Get-Acl Protected
$rule = New-Object System.Security.AccessControl.FileSystemAccessRule( `
  "Administrator",2032127,3,0,0)
$acl.AddAccessRule($rule)
$rule = New-Object System.Security.AccessControl.FileSystemAccessRule( `
  "Everyone",131241,3,0,0)
$acl.AddAccessRule($rule)
# Write back changed permissions:
Set-Acl Protected $acl
```

Finally, let's look at how PowerShell specifies persons to whom permissions apply. In the above examples, you specified the names of users or of groups. Because permissions are not responsive to names, but to the unique SIDs of user accounts, names are changed internally to SIDs. You can also change names manually to see whether a specified user account in fact exists:

```
$Account = [System.Security.Principal.NTAccount]"Administrators"
$SID = $Account.translate([System.Security.Principal.Securityidentifier])
$SID

   BinaryLength  AccountDomainSid         Value
   ------------  ----------------         -----
   16                                  S-1-5-32-544
```

An *NTAccount* object describes a security principal, which is something to which permissions can be granted. In practice, this is users and groups. The *NTAccount* object can use *Translate()* to output the information it contains through the principal into its SID. However, this will only work if the specified account in fact exists. Otherwise, you will get an error, so you should use *Translate()* to validate the existence of the account.

The unique SID that *Translate()* retrieves is also useful. If you look closely, you'll discover that the SID of the *Administrators* group clearly differs from the SID of your own user account:

```
([System.Security.Principal.NTAccount]"$env:userdomain\$env:username").`
Translate([System.Security.Principal.Securityidentifier]).Value

  S-1-5-21-3347592486-2700198336-2512522042-1000

([System.Security.Principal.NTAccount]"Administrators").`
Translate([System.Security.Principal.Securityidentifier]).Value
```

```
    S-1-5-32-544
```

The SID of the *Administrators* group is not only much shorter, but also unique. For its integrated accounts, Windows uses so-called "well-known" SIDs, which are the same in all Windows systems. This is important because if you were to run your above script on a German system, it would fail since the *Administrators* group is called "*Administratoren*," and the "*Everyone*" group is called "*Jeder*" on systems localized for Germany. The SIDs of these groups are identical, and knowing this for integrated accounts, you should use SIDs instead of localized names. This is how you turn a SID into the name of a user account:

```
$sid = [System.Security.Principal.SecurityIdentifier]"S-1-1-0"
$sid.Translate([System.Security.Principal.NTAccount])

  Value
  -----
  Everyone
```

And this is how your script could work flawlessly in international localizations:

```
Del Protected
Md Protected
$acl = Get-Acl Protected
# Full access for Administrators:
$sid = [System.Security.Principal.SecurityIdentifier]"S-1-5-32-544"
$access = [System.Security.AccessControl.FileSystemRights]"FullControl"
$rule = New-Object System.Security.AccessControl.FileSystemAccessRule( `
  $sid,$access,3,0,0)
$acl.AddAccessRule($rule)
# Read access for all:
$sid = [System.Security.Principal.SecurityIdentifier]"S-1-1-0"
$access = [System.Security.AccessControl.FileSystemRights]"ReadAndExecute"
$rule = New-Object System.Security.AccessControl.FileSystemAccessRule( `
  $sid,$access,3,0,0)
$acl.AddAccessRule($rule)
# Write back changed permissions:
Set-Acl Protected $acl
```

CHAPTER 16.

The Registry

You can navigate the Windows registry just as you would the file system because PowerShell treats the file system concept discussed in Chapter 15 as a prototype for all hierarchical information systems.

Topics Covered:

You can navigate the Windows registry just as you would the file system because PowerShell treats the file system concept discussed in Chapter 15 as a prototype for all hierarchical information systems:

```
Cd HKCU:Dir

  SKC  VC Name                      Property
```

```
---   -- ----                   --------
  2    0 AppEvents              {}
 17    1 Console                {CurrentPage}
 15    0 Control Panel          {}
  0    3 Environment            {PATH, TEMP, TMP}
  4    0 EUDC                   {}
  1    6 Identities             {Identity Ordinal, Migrated7, Last Username, Last
User ID...}
  3    0 Keyboard Layout        {}
  0    0 Network                {}
  4    0 Printers               {}
 55    1 Software               {(default)}
  2    0 System                 {}
  0    1 SessionInformation     {ProgramCount}
  1    8 Volatile Environment   {LOGONSERVER, USERDOMAIN, USERNAME, USERPROFILE...}
```

The keys in the registry correspond to directories in the file system. However, key values don't quite behave analogously to files in the file system. Instead, they are managed as properties of keys and are displayed in the *Property* column. Table 16.1 lists all the commands that you require for access to the registry.

Command	**Description**
Dir, Get-ChildItem	Lists the contents of a key
Cd, Set-Location	Changes current directory (key)
HKCU:, HKLM:	Predefined drives for the two most important roots of the registry
Get-ItemProperty	Reads the value of a key
Set-ItemProperty	Modifies the value of a key
New-ItemProperty	Creates a new value for a key
Clear-ItemProperty	Deletes the value contents of a key
Remove-ItemProperty	Removes the value of a key
New-Item, md	Creates a new key
Remove-Item, Del	Deletes a key

Test-Path	Verifies whether a key exists

Table 16.1: The most important commands for working with the registry

note

The registry stores nearly all central Windows settings. That's why it's an important location for reading information and modifying the Windows configuration. Incorrect entries or erroneous deletion and modification represent a serious risk and can damage Windows or make it unbootable.

You'll find the most important settings in the *HKEY_LOCAL_MACHINE* root key, which Windows protects by requiring administrator rights to make changes there.

"Provider": Locations Outside the File System

PowerShell has a modular structure and uses what are called "providers," Which are responsible for a particular information store. In the last chapter, you used a file system provider so you'll need a registry provider if you want to access the Windows registry instead of the file system. In other respects, everything works the way it did in the last chapter. You use the same commands in the registry that you use in the file system.

Available Providers

Get-PSProvider retrieves a list of all installed providers. Your list could be longer than in the following example, because providers can be added later on. For example, PowerShell doesn't have its own provider for Active Directory.

```
Get-PSProvider

  Name                 Capabilities                 Drives
  ----                 ------------                 ------
  Alias                ShouldProcess                {Alias}
  Environment          ShouldProcess                {Env}
  FileSystem           Filter, ShouldProcess        {C, E, S, D}
  Function             ShouldProcess                {Function}
  Registry             ShouldProcess                {HKLM, HKCU}
  Variable             ShouldProcess                {Variable}
  Certificate          ShouldProcess                {cert}
```

What's interesting here is the "Drives" column, which names the drives that are managed by respective providers. As you see, the registry provider mounts the drives *HKLM:* (for the registry root *HKEY_LOCAL_MACHINE*) and *HKCU:* (for the registry root *HKEY_CURRENT_USER*). These drives work just like traditional file system drives. Try this out:

```
Cd HKCU:
Dir


  Hive: Microsoft.PowerShell.Core\Registry::HKEY_CURRENT_USER
  SKC  VC Name                           Property
  ---  -- ----                           --------
    2   0 AppEvents                      {}
    7   1 Console                        {CurrentPage}
   15   0 Control Panel                  {}
    0   2 Environment                    {TEMP, TMP}
    4   0 EUDC                           {}
    1   6 Identities                     {Identity Ordinal, Migrated7, Last ...
    3   0 Keyboard Layout                {}
    0   0 Network                        {}
    4   0 Printers                       {}
  38   1 Software                       {(default)}
    2   0 System                         {}
    0   1 SessionInformation             {ProgramCount}
    1   8 Volatile Environment           {LOGONSERVER, USERDOMAIN, USERNAME,...
```

From this location, you could navigate through the "subdirectory" in exactly the same way you did through a genuine file system. The same special characters apply here as well. The symbol for the root directory "~" is unknown in the registry and generates an error.

While the other providers do not have a role in this chapter since we will be focusing on the registry, they are listed in Table 16.2 for reference.

Provider	**Description**	**Example**
Alias	Manages aliases, which enable you to address a command under another name. You'll learn more about aliases in Chapter 2.	*Dir Alias:* *$alias:Dir*
Environment	Provides access to the environment variables of the system. More in Chapter 3.	*Dir env:* *$env:windir*
Function	Lists all defined functions. Functions operate much like macros and can combine several commands under one name. Functions can also be an alternative to aliases and will be described in detail in Chapter 9.	*Dir function:* *$function:tabexpansion*

FileSystem	Provides access to drives, directories and files.	*Dir c:* *$ (c:\autoexec.bat)*
Registry	Provides access to branches of the Windows registry.	*Dir HKCU:* *Dir HKLM:*
Variable	Manages all the variables that are defined in the PowerShell console. Variables are covered in Chapter 3.	*Dir variable:* *$variable:pshome*
Certificate	Provides access to the certificate store with all its digital certificates. These are examined in detail in Chapter 10.	*Dir cert:* *Dir cert: -recurse*

Table 16.2: Default providers

Creating Drives

Registry provider provides access to the registry. You address them through drives. If you would like to see which drives are already used by registry provider, use *Get-PSDrive* with *-PSProvider*:

```
Get-PSDrive -PSProvider Registry

  Name        Provider       Root
  ----        --------       ----
  HKCU        Registry       HKEY_CURRENT_USER
  HKLM        Registry       HKEY_LOCAL_MACHINE
```

Here it might have struck your attention that the registry consists of more roots than just these two.

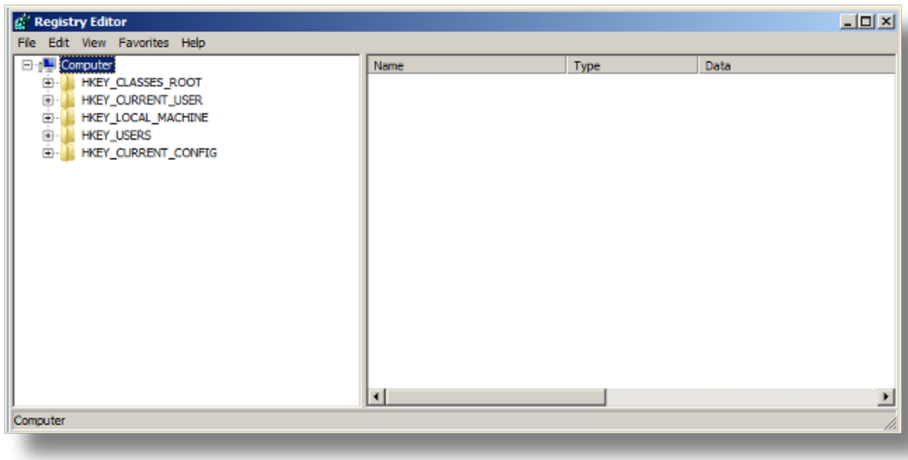


Figure 16.1: Roots in the registry

The root *HKEY_CLASSES_ROOT* is actually not an independent root but corresponds to *HKEY_LOCAL_MACHINE\SOFTWARE\Classes*. That means you could use *New-PSDrive* to create a new drive that has its starting point there:

```
New-PSDrive -name HKCR -PSProvider registry -root HKLM:\SOFTWARE\Classes
Dir HKCR:
```

You already have access to this registry branch. In fact, you could get direct access to any of the roots listed in Figure 16.1.

```
Remove-PSDrive HKCR
New-PSDrive -name HKCR -PSProvider registry -root HKEY_CLASSES_ROOT
Dir HKCR:
```

tip

You could create any additional drives you like when you're working extensively in a specific registry area:

```
        New-PSDrive job1 registry `
  "HKLM:\Software\Microsoft\Windows NT\CurrentVersion"
Dir job1:


  Hive: Microsoft.PowerShell.Core\Registry::
  HKEY_LOCAL_MACHINE\Software\Microsoft\Windows NT\CurrentVersion
  SKC  VC Name                   Property
  ---  -- ----                   --------
    1   0 Accessibility          {}
    1   3 AeDebug                {UserDebuggerHotKey, Auto,
  Debugger}
    0  10 APITracing             {LogFileDirectory,
  InstalledManifests,
                                  LogApiNamesOnly, ...
    4   1 AppCompatFlags         {ApphelpUIExe}
```

```
      1   0 ASR                     {}
      0 174 Compatibility           {_3DPC, _BNOTES, _LNOTES, ACAD...}
      0   1 Compatibility32         {winword}
      3   0 Console                 {}
      1   2 CorruptedFileRecovery   {RunCount, TraceLevel}
      0   3 DefaultProductKey       {ProductId, DigitalProductId,
                                     DigitalProductId4}
      2   1 DiskDiagnostics         {DFDCollectorInvokeTimes}
    (...)
```

Searching the Registry

Using *Dir*, you can search the registry just like you did the file system in Chapter 15. Simply use the new drives that the registry provider uses. The drive *HKCU:* provides an overview of the contents of the *HKEY_CURRENT_USER* root key:

```
Cd HKCU:
Dir
```

Redirect the result to *Format-List* if you'd rather list contents below each other:

```
Dir | Format-List
Dir | Format-List Name
Dir | Format-List *
```

Recursive Search

The registry provider doesn't support any filters so you may not use the *Dir* parameter *-filter* when you search the registry. However, the parameters *-recurse*, *-include*, and *-exclude* are supported; you used them in the last chapter to search the file system recursively. This works in the registry as well. For example, if you wanted to know the location of registry entries that include the word "PowerShell", you could search using:

```
Dir HKCU:, HKLM: -recurse -include *PowerShell*
```

This instruction searches the *HKEY_CURRENT_USER* root first and then the *HKEY_LOCAL_MACHINE* root. It finds all the keys that contain the word "PowerShell." Because there could be a large number of these, search for registry keys that have the word "PowerShell" in their names without using any wildcard characters. Search operations of this kind usually generate error messages because when you search, segments of the registry are read to which you may have no access authorization. To filter the messages out of the result, use the parameter *-ErrorAction* and set its value to *SilentlyContinue*:

```
Dir HKCU:, HKLM: -recurse -include PowerShell -ErrorAction SilentlyContinue
```

```
    Hive: Microsoft.PowerShell.Core\Registry::
    HKEY_LOCAL_MACHINE\SOFTWARE\Classes\Directory\shell
    SKC  VC Name          Property
    ---  -- ----          --------
      1   1 PowerShell    {(default)}
    Hive: Microsoft.PowerShell.Core\Registry::
    HKEY_LOCAL_MACHINE\SOFTWARE\Classes\Drive\shell
    SKC  VC Name          Property
    ---  -- ----          --------
      1   1 PowerShell    {(default)}
    Hive: Microsoft.PowerShell.Core\Registry::
    HKEY_LOCAL_MACHINE\SOFTWARE\Microsoft
    SKC  VC Name          Property
    ---  -- ----          --------
      1   0 PowerShell    {}
```

Individual Registry Keys

Every element that *Dir* retrieves corresponds to a registry key (*Microsoft.Win32.Registry* object) that includes these important properties:

```
  $key = Dir HKCU: | Select-Object -first 1
  $key.GetType().FullName

    Microsoft.Win32.RegistryKey

  $key | Get-Member -memberType *Property

    TypeName: Microsoft.Win32.RegistryKey
    Name          MemberType   Definition
    ----          ----------   ----------
    Property      NoteProperty System.String[] Property=System.String[]
    PSChildName   NoteProperty System.String PSChildName=AppEvents
    PSDrive       NoteProperty System.Management.Automation.PSDriveInfo PSDrive=HKCU
    PSIsContainer NoteProperty System.Boolean PSIsContainer=True
    PSParentPath  NoteProperty System.String
    PSParentPath=Microsoft.PowerShell.Core\Registry::HKEY_...
    PSPath        NoteProperty System.String
    PSPath=Microsoft.PowerShell.Core\Registry::HKEY_CURREN...
    PSProvider    NoteProperty System.Management.Automation.ProviderInfo
    PSProvider=Microsoft.Power...
    Name          Property     System.String Name {get;}
    SubKeyCount   Property     System.Int32 SubKeyCount {get;}
    ValueCount    Property     System.Int32 ValueCount {get;}
```

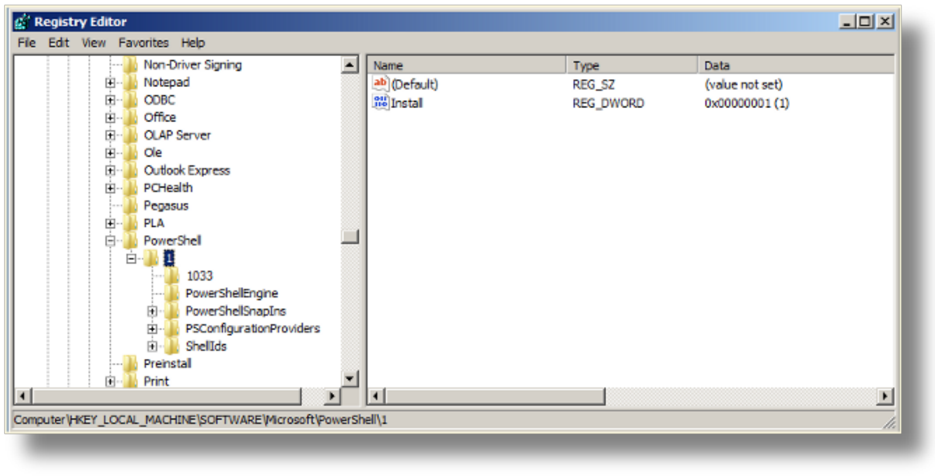
Property	**Description**
Name	Path of a key as displayed in the registry editor

Property	Array including names of values stored in a key
PSChildName	Name of current key
PSDrive	Registry root for a key
PSParentPath	Parent key
PSPath	PowerShell path of a key. Use *Dir* to view contents of a key under this path
PSProvider	Name of provider: *Registry*
SubKeyCount (SKC)	Number of keys stored in a key
ValueCount (VC)	Number of values stored in a key
PSIsContainer	Always *True*

Table 16.3: Properties of a Microsoft.Win32.Registry object (registry key)

How PowerShell Addresses Registry Keys

Let's take a closer look at the allocation of individual properties to a real key. In the example, the *HKLM:\Software\Microsoft\PowerShell\1* key is used and in Figure 16.2 shown as displayed in the registry editor. This is the registry location where PowerShell stores its internal settings.



Name	Type	Data
(Default)	REG_SZ	(value not set)
Install	REG_DWORD	0x00000001 (1)

Computer\HKEY_LOCAL_MACHINE\SOFTWARE\Microsoft\PowerShell\1

Figure 16.2: PowerShell settings in the registry editor

Use *Get-Item* from within PowerShell to access the key:

```
$key = Get-Item HKLM:\Software\Microsoft\PowerShell\1
$key.Name

  HKEY_LOCAL_MACHINE\Software\Microsoft\PowerShell\1

# Read PowerShell properties:
$key | Format-List ps*

  PSPath        :
  Microsoft.PowerShell.Core\Registry::HKEY_LOCAL_MACHINE\Software\Microsoft\PowerSh
  ell\1
  PSParentPath  :
  Microsoft.PowerShell.Core\Registry::HKEY_LOCAL_MACHINE\Software\Microsoft\PowerSh
  ell
  PSChildName   : 1
  PSDrive       : HKLM
  PSProvider    : Microsoft.PowerShell.Core\Registry
  PSIsContainer : True
```

As expected, the *Name* property retrieves the complete name of the key. Of greater interest are the properties that begin with "PS" and which PowerShell subsequently adds. They split the path of the registry key into various segments.

Values of Keys

Values of keys are in Figure 16.2 in the right column of the registry editor. There are three values. PowerShell reports just two values:

```
$key.ValueCount

  2
```

One value seems to be missing. You'll see which values PowerShell records if you look more closely at the *Property* property:

```
$key.Property

  Install
  PID
```

These names correspond to the names of values in Figure 16.2. The value (*Default*) is missing, and rightly so, because as you can see in **Figure 16.2**, the default value is empty. The registry editor, *Regedit*, reports: *(value not set)*.

If you want to retrieve the contents of values, use *Get-ItemProperty* and pass the path from the *PSPath* property:

```
Get-ItemProperty $key.PSPath

  PSPath       :
  Microsoft.PowerShell.Core\Registry::HKEY_LOCAL_MACHINE\Software\Microsoft\PowerSh
  ell\1
  PSParentPath :
  Microsoft.PowerShell.Core\Registry::HKEY_LOCAL_MACHINE\Software\Microsoft\PowerSh
  ell
  PSChildName  : 1
  PSProvider   : Microsoft.PowerShell.Core\Registry
  Install      : 1
  PID          : 89383-100-0001260-04309
```

In this way, all the values of the registry key are automatically retrieved and displayed. As you see, along with usual properties, the value contains other properties added by PowerShell. You should access their corresponding properties if you want to retrieve only some particular values:

```
# Retrieve all values of a registry key
$values = Get-ItemProperty $key.PSPath
# Obtain value for Install:
$values.Install

  1

# Obtain value for PID:
$values.PID

  89383-100-0001260-04309
```

If you want to retrieve all the values of a key, without including the properties added by PowerShell, you could proceed as follows:

```
$key = Get-Item HKLM:\Software\Microsoft\PowerShell\1
$values = Get-ItemProperty $key.PSPath
foreach ($value in $key.Property) { $value + "=" + $values.$value }
```

```
    Install=1
    PID=89383-100-0001260-04309
```

tip

Once you have navigated through the registry to the key whose values you want to examine, you can list values using a second method:

```
    Cd HKLM:\Software\Microsoft\PowerShell\1
(Get-ItemProperty .).PID

   89383-100-0001260-04309
```

Here "." was used to pass *Get-ItemProperty* to the relative path of the registry key. For this to work, you should use *Cd* first to switch to the key so your current directory must correspond to the registry key that you are interested in:

Get-ItemProperty

You should use *Dir* if you'd like to output the values of several keys. The result of *Dir* can be passed along in the pipeline to *ForEach-Object*. In this way, you could evaluate all the subkeys of a key one after the other and, for example, access the respective values of the key. The next line lists all the subkeys of *Uninstall* and then reports the values *DisplayName* and *MoreInfoURL*. This provides you with a rough list of installed programs:

```
Dir hklm:\software\microsoft\windows\currentversion\uninstall |
  ForEach-Object { Write-Host -ForegroundColor Yellow "Installed
Products:" }{
    $values = Get-ItemProperty $_.PSPath;
    "{0:-30} {1:20}" -f $values.DisplayName, $values.MoreInfoURL
  }{Write-Host -ForegroundColor Yellow "Finished!"}
```

Subkey of a Key

In Figure 16.2, you can see in the left column that this key contains four subkeys. PowerShell also reports four subkeys:

```
$key.SubKeyCount

   4
```

Dir retrieves the names of subkeys. To accomplish this, pass to *Dir* the PowerShell path of the key that you find in the *PSPath* property:

```
Dir $key.PSPath

   Hive:
   Microsoft.PowerShell.Core\Registry::HKEY_LOCAL_MACHINE\Software\Microsoft\PowerSh
   ell\1
```

```
    SKC  VC Name                 Property
    ---  -- ----                 --------
      0   1 1033                 {Install}
      0   5 PowerShellEngine     {ApplicationBase, RuntimeVersion,
    ConsoleHostAssemblyNam...
      1   0 PowerShellSnapIns    {}
      1   0 ShellIds             {}
```

Creating and Deleting Keys and Values

Use *New-item* or the *md* function to create new keys. Keys in the registry behave like directories in the file system.

```
  New-Item -type Directory HKCU:\Software\Test1


    Hive: Microsoft.PowerShell.Core\Registry::HKEY_CURRENT_USER\Software
    SKC  VC Name                           Property
    ---  -- ----                           --------
      0   0 Test1                          {}

  md HKCU:\Software\Test2


    Hive: Microsoft.PowerShell.Core\Registry::HKEY_CURRENT_USER\Software
    SKC  VC Name                           Property
    ---  -- ----                           --------
      0   0 Test2                          {}
```

But the two statements create a key that is completely empty: its default value is not defined. If you want to define the default value of a key, use *New-Item* instead of *md*, and specify one of the values in Table 16.4 as *-itemType*. Set the value of the default entry using the *-value* parameter:

```
  New-Item -itemType String HKCU:\Software\Test3 -value "A default value"


    Hive: Microsoft.PowerShell.Core\Registry::HKEY_CURRENT_USER\Software
    SKC  VC Name                           Property
    ---  -- ----                           --------
      0   1 Test3                          {(default)}
```

If you want to delete a key, proceed the way you did in the file system and use *Remove-Item* or the short *Del*:

```
  Remove-Item HKCU:\Software\Test1
  Del HKCU:\Software\Test2
  Del HKCU:\Software\Test3
```

ItemType	Description	DataType

String	A string	*REG_SZ*
ExpandString	A string with environment variables that are resolved when invoked	*REG_EXPAND_SZ*
Binary	Binary values	*REG_BINARY*
DWord	Numeric values	*REG_DWORD*
MultiString	Text of several lines	*REG_MULTI_SZ*
QWord	64-bit numeric values	*REG_QWORD*

Table 16.4: Permitted ItemTypes in the registry

Deleting Keys with Contents

If a key name includes blank characters, enclose the path in quotation marks. Unfortunately, you can't create more than one key in one step the way you could in the file system. The parent key has to exist. That's why this statement has caused an error; the parent key, *First key*, was missing:

```
md "HKCU:\Software\First key\Second key"

  New-Item : The registry key at the specified path does not exist.
  At line:1 char:34
  + param([string[]]$paths); New-Item  <<<< -type directory -path $paths
```

You have to split up the statement into several steps:

```
md "HKCU:\Software\First key" | Out-Null
md "HKCU:\Software\First key\Second key" | Out-Null
```

If you try to delete the *First key* now, you'll be queried, like you were in the file system, because the key includes subkeys and isn't empty:

```
Del "HKCU:\Software\First key"

  Confirm
  The item at "HKCU:\Software\First key" has children and the Recurse
  parameter was not specified. If you continue, all children will be
```

```
    removed with the item. Are you sure you want to continue?
    [Y] Yes  [A] Yes to All  [N] No  [L] No to All  [S] Suspend
    [?] Help (default is "Y"):
```

Use the *-recurse* parameter to explicitly delete keys that have contents:

```
  Del "HKCU:\Software\First key" -recurse
```

Setting, Changing, and Deleting Values of Keys

The registry editor distinguishes between keys and values in a well-structured way: keys are in the left column with values in the right. The keys correspond to directories in the file system, and values correspond to files in the directory. If you want to create a new key, use *md* as you did above or, even better, *New-Item*, and then use *New-Item* and the *-itemType* and *-value* parameters to assign a default value to your new key.

```
  New-Item HKCU:\Software\Testkey -itemType String -value "A test value" |
    Out-Null
```

Adding New Values

Unfortunately, the file system analogy won't help you if you want to add additional values to a key, because normally you would use *Set-Content* to create new files inside a directory. But the registry provider is not the right tool:

```
  Set-Content HKCU:\Software\Testkey\Value1 "Contents"

    Set-Content : Cannot use interface. The IcontentCmdletProvider
    interface is not implemented by this provider.
    At line:1 char:12
    + Set-Content  <<<< HKCU:\Software\Testkey\Value1 "Contents"
```

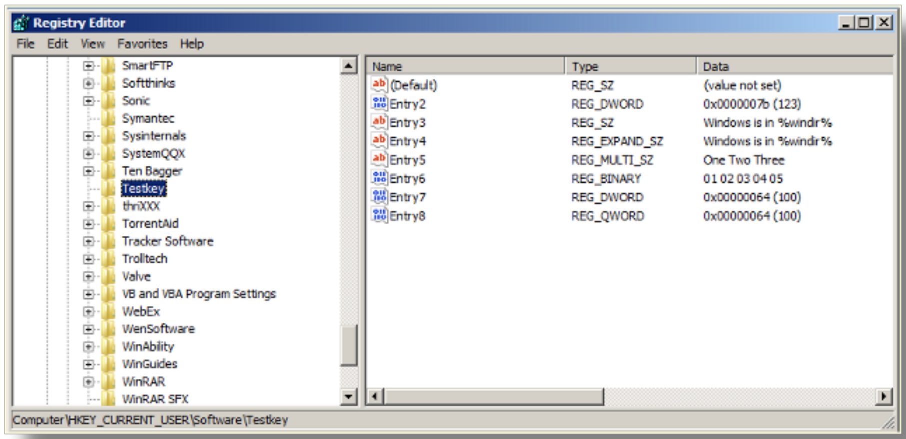
Instead, use *Set-ItemProperty* to add new values to a key:

```
  Set-ItemProperty HKCU:\Software\Testkey -name "Entry1" -value "123"
```

The values that you add in this way are automatically registered as REG_SZ values in the registry, that is, as a string. If you want to use another data type, use *New-ItemProperty* and the *-propertyType* parameter. It accepts the types listed in Table 16.4:

```
  # Create Testkey if you haven't done so already:
  if (!(Test-Path HKCU:\Software\Testkey)) { md HKCU:\Software\Testkey }
  New-ItemProperty HKCU:\Software\Testkey -name "Entry2" `
    -value "123" -propertyType dword

    PSPath       : Microsoft.PowerShell.Core\Registry::
                   HKEY_CURRENT_USER\Software\Testkey
    PSParentPath : Microsoft.PowerShell.Core\Registry::
                   HKEY_CURRENT_USER\Software
    PSChildName   : Testkey
    PSDrive       : HKCU
    PSProvider    : Microsoft.PowerShell.Core\Registry
    Entry2        : 123

  New-ItemProperty HKCU:\Software\Testkey Entry3 `
    -value "Windows is in %windir%" -propertyType string
  New-ItemProperty HKCU:\Software\Testkey Entry4 `
    -value "Windows is in %windir%" -propertyType expandstring
  New-ItemProperty HKCU:\Software\Testkey Entry5 `
    -value "One","Two","Three" -propertyType multistring
  New-ItemProperty HKCU:\Software\Testkey Entry6 `
    -value 1,2,3,4,5 -propertyType binary
  New-ItemProperty HKCU:\Software\Testkey Entry7 `
    -value 100 -propertyType dword
  New-ItemProperty HKCU:\Software\Testkey Entry8 `
    -value 100 -propertyType qword
```

The registry editor shows the result in Figure 16.3.



Name	Type	Data
(Default)	REG_SZ	(value not set)
Entry2	REG_DWORD	0x0000007b (123)
Entry3	REG_SZ	Windows is in %windir%
Entry4	REG_EXPAND_SZ	Windows is in %windir%
Entry5	REG_MULTI_SZ	One Two Three
Entry6	REG_BINARY	01 02 03 04 05
Entry7	REG_DWORD	0x00000064 (100)
Entry8	REG_QWORD	0x00000064 (100)

Computer\HKEY_CURRENT_USER\Software\Testkey

Figure 16.3: Writing various data types in the registry

If you have the *Microsoft.Win32.Registry* object of a key available, you can add and read out additional values easily by using the *SetValue()* and *GetValue()* methods. When you use *md* or *New-Item* to create a new key, this object is what you will get as a result, and all you have to do is to save it so that you can add additional values to it in the next step:

```
  # Creating key having several values:
  $key = md HKCU:\Software\Test2
  $key.SetValue("Entry1", "123")
  $key.SetValue("Entry2", "123", "Dword")
  $key.SetValue("Entry3", "%windir%", "ExpandString")
  $key.GetValue("Entry3")

    C:\Windows
```

The *SetValue()* method works only for keys that you created again using *New-Item* or *md* because PowerShell will open only those keys that have write permissions. Existing keys that you get by using *Get-Item* will be opened in read-only mode. You can't use *SetValue()* to change values in this instance. Instead, use *Set-ItemProperty*(see below).

Reading Values

Reading registry values is the only area in which the rules are not particularly clear. Normally, you would assume that values created using *Set-ItemProperty* could be read using *Get-ItemProperty*. Unfortunately, that's only partly true because when you use *Get-ItemProperty*, PowerShell retrieves not only the value you're looking for but also an object with extraneous PowerShell properties:

```
Get-ItemProperty HKCU:\Software\Testkey Entry3

  PSPath       : Microsoft.PowerShell.Core\Registry::
                 HKEY_CURRENT_USER\Software\Testkey
  PSParentPath : Microsoft.PowerShell.Core\Registry::
                 HKEY_CURRENT_USER\Software
  PSChildName  : Testkey
  PSDrive      : HKCU
  PSProvider   : Microsoft.PowerShell.Core\Registry
  Entry3       : Windows is in %windir%
```

You'll get the information you want only when you explicitly retrieve the right property from the object that That is, *Get-ItemProperty* retrieves the name of the value that interests you. An incidental consequence is that the difference between the file types *REG_SZ* and *REG_EXPAND_SZ* becomes clear.

```
(Get-ItemProperty HKCU:\Software\Testkey Entry3).Entry3

  Windows is in %windir%

(Get-ItemProperty HKCU:\Software\Testkey Entry4).Entry4

  Windows is in C:\Windows
```

Because *Entry3* was stored as a *REG_SZ* value, you will get the precise string value that was stored there when you read it. *Entry4* is of the *REG_EXPAND_SZ* type. Windows automatically resolves environment variables contained in the string when they are retrieved. That's why the Windows directory was retrieved, instead of the environment variable.

note

Perhaps you're wondering why in the last examples the name of the value that you want to read out occurred twice:

```
(Get-ItemProperty HKCU:\Software\Testkey Entry3).Entry3
```

In this example, *Get-ItemProperty* retrieves the *Entry3* value. However, you've seen that what *Get-ItemProperty* retrieves is an object that has several properties. You can enclose your invocation in parentheses so that your subexpression will be evaluated first since you're only interested in the *Entry3* value.,. Finally, get the property you want from the returned object, *Entry3*.

The following statement seems to do exactly that or at least it returns the same result:

```
(Get-ItemProperty HKCU:\Software\Testkey).Entry3
```

Here, however, you should instruct *Get-ItemProperty* to get all the values of the key, which will be far more than you'll actually need.

Deleting Values

Use *Remove-ItemProperty* to remove a value. The next instruction deletes the *Entry5* value that you created in the previous example:

```
Remove-ItemProperty HKCU:\Software\Testkey Entry5
```

tip

Clear-ItemProperty deletes only the contents of a value, but not the value itself.

Default Entry

The default entry of the key plays a special role. It is always shown in the right column under the name (default). But this entry is actually unnamed: it is the only value of a key that has no name.

The default value of a key doesn't have to be defined. If the value isn't set, the registry editor will display "value not set." Normally, you would set a value when using *New-Item* and the *-value* parameter to create new keys. But you can also directly address the value by the name *(default)*:

```
# Create an empty Testkey
md HKCU:\Software\Test3
# Verify creation of the default value:
```

```
Get-ItemProperty HKCU:\Software\Test3 "(default)"

  Get-ItemProperty : Property (default) does not exist
  at path HKEY_CURRENT_USER\Software\Test3.
  At line:1 char:17
  + Get-ItemProperty  <<<< HKCU:\Software\Test3 "(default)"

# Create default value:
New-ItemProperty HKCU:\Software\Test3 "(default)" -value "A value"
# Verify creation of the default value:
Get-ItemProperty HKCU:\Software\Test3 "(default)"

  PSPath       : Microsoft.PowerShell.Core\Registry::
                 HKEY_CURRENT_USER\Software\Test3
  PSParentPath : Microsoft.PowerShell.Core\Registry::
                 HKEY_CURRENT_USER\Software
  PSChildName  : Test3
  PSDrive      : HKCU
  PSProvider   : Microsoft.PowerShell.Core\Registry
  (default)    : A value

# Read contents of the default value
(Get-ItemProperty HKCU:\Software\Test3 "(default)")."(default)"

  A value

# Delete default value:
# Owing to a PowerShell bug you can set the default value
# to "empty" only. Remove-ItemProperty will not function here:
Clear-ItemProperty HKCU:\Software\Test3 "(default)"
```

important

Be sure to delete your test key in the registry asthe registry is no place to leave irrelevant entries behind:

```
         Del HKCU:\Software\Testkey -recurse
Del HKCU:\Software\Test2 -recurse
Del HKCU:\Software\Test3 -recurse
```

Example: Extending the Context Menu

Entries in the registry can have widely varying consequences. Among others, this is where Windows sets the entries for the Explorer context menu. In the next example, you will, as a test, add three new commands to the context menu for PowerShell scripts: "*Execute and Leave Open*," "*Execute and Close*," and "*Edit*".

Executing and Editing PowerShell Scripts

To do this, you have to know first how to launch PowerShell scripts outside the PowerShell console. It's easy. First, create a little example script:

```
Cd $home
# Create an example script
'"Hello world!"' | Out-File test.ps1
```

Inside the PowerShell console, invoke the script by typing its relative or absolute path:

```
.\test.ps1
```

But how to invoke PowerShell scripts outside the PowerShell console? Start *powershell.exe* and specify the -*NoExit* option so that the console will stay open after the script has been processed, allowing you to see and evaluate the results of the script. After the -*Command* parameter, specify the command line that PowerShell is supposed to execute. Enclose the path in single quotation marks and put the call operator in front of it because you don't know whether the path of the script contains blank characters. Put this command inside double quotation marks:

```
powershell.exe -NoExit -Command "& '.\test.ps1'"
```

If you would like to edit a script, the command is much simpler: invoke the editor of your choice and pass the script to it:

```
notepad.exe ".\test.ps1"
```

The context menu extension will be entered into the registry next. This requires administrator privileges:

```
# Create shortcut for HKEY_CLASSES_ROOT:
New-PSDrive -Name HKCR -PSProvider registry -root HKEY_CLASSES_ROOT | Out-Null
# Find out key name that is assinged to the PS1 file:
$keyname = (Get-ItemProperty HKCR:\.ps1)."(default)"
# Add three new commands:
New-Item ("HKCR:\$keyname\shell\execute1") -value `
  'Execute and Leave Open' -type String
New-Item ("HKCR:\$keyname\shell\execute1\command") -value `
  "powershell.exe -NoExit -Command `"& '%L'`"" -type String
New-Item ("HKCR:\$keyname\shell\execute2") -value `
  'Execute and Close' -type String
New-Item ("HKCR:\$keyname\shell\execute2\command") -value `
  "powershell.exe -Command `"& '%L'`"" -type String
New-Item ("HKCR:\$keyname\shell\editnotepad") -value `
  'Edit with Notepad' -type String
New-Item ("HKCR:\$keyname\shell\editnotepad\command") -value `
  'notepad.exe "%L"' -type String
# Set icon
# Delete if it already exists:
if (Test-Path ("HKCR:\$keyname\DefaultIcon")) {
  Del ("HKCR:\$keyname\DefaultIcon") }
$icon = '%windir%\System32\WindowsPowerShell\v1.0\powershell.exe,0'
```

```
New-Item ("HKCR:\$keyname\DefaultIcon") -value $icon -type ExpandString
```

Permissions in the Registry

In Chapter 15, you learned in detail how to control permissions for files and directories. The same mechanisms also work in the registry as you could use *Get-Acl* to show current permissions of a key:

```
md HKCU:\Software\Testkey
Get-Acl HKCU:\Software\Testkey

  Path                          Owner                          Access
  ----                          -----                          ------
  Microsoft.PowerShell.Core... TobiasWeltne-PC\Tobias Weltner TobiasWeltne-
  PC\Tobias Weltner A...
```

Because you manage permissions exactly the way you do in the file system, you should take another look at Chapter 15 and review the basics before assigning new permissions to a registry key.

The .NET classes that are required for permissions in the registry are a little different from the ones in the file system. Instead of a *FilesystemAccessRule*, you will need a *RegistryAccessRule*, and the fundamental difference between them is the diverging access rights that can be set in them. In a *RegistryAccessRule*, permissions do not correpond to the *FilesystemRights* enumeration, but to *RegistryRights*:

```
[System.Enum]::GetNames([System.Security.AccessControl.RegistryRights])

  QueryValues
  SetValue
  CreateSubKey
  EnumerateSubKeys
  Notify
  CreateLink
  Delete
  ReadPermissions
  WriteKey
  ExecuteKey
  ReadKey
  ChangePermissions
  TakeOwnership
  FullControl
```

Taking Ownership

Make sure that you are the "owner" of the key before modifying key permissions as a test. Only if you are the owner you will be able to undo possible mistakes. This is how to take ownership of a registry key (to the extent that your permissions allow it):

```
$acl = Get-Acl HKCU:\Software\Testkey
$acl.Owner
```

```
  scriptinternals\TobiasWeltner

$me = [System.Security.Principal.NTAccount]"$env:userdomain\$env:username"
$acl.SetOwner($me)
```

Setting New Access Permissions

The next step is to assign new permissions to the key. The group "Everyone" is prohibited from making changes to this key:

```
$acl = Get-Acl HKCU:\Software\Testkeys
$person = [System.Security.Principal.NTAccount]"Everyone"
$access = [System.Security.AccessControl.RegistryRights]"WriteKey"
$inheritance = [System.Security.AccessControl.InheritanceFlags]"None"
$propagation = [System.Security.AccessControl.PropagationFlags]"None"
$type = [System.Security.AccessControl.AccessControlType]"Deny"
$rule = New-Object System.Security.AccessControl.RegistryAccessRule( `
  $person,$access,$inheritance,$propagation,$type)
$acl.AddAccessRule($rule)
Set-Acl HKCU:\Software\Testkey $acl
```

The modifications immediately go into effect.Try creating new subkeys in the registry editor or from within PowerShell to check and you'll get an error message:

```
md HKCU:\Software\Testkey\subkey

  New-Item : Requested registry access is not allowed.
  At line:1 char:34
  + param([string[]]$paths); New-Item  <<<< -type directory -path $paths
```

tip

If you're asking yourself why the restriction also applies to you because as administrator you're supposed to have full access: restrictions always have priority over permissions, and because everyone is a member of the *Everyone* group, the restriction applies to you as well.

Removing an Access Rule

The new rule for *Everyone* was a complete waste of time and didn't stand the test. So, how do you go about removing a rule? You can use *RemoveAccessRule()* to remove a particular rule, and *RemoveAccessRuleAll()* to remove all rules of the same type (permission or restriction) for the user named in the specified rule. *ModifyAccessRule()* changes an existing rule, and *PurgeAccessRules()* removes all rules for a certain user.

To remove the rule that was just inserted, proceed as follows:

```
$acl = Get-Acl HKCU:\Software\Testkey
$person = [System.Security.Principal.NTAccount]"Everyone"
$access = [System.Security.AccessControl.RegistryRights]"WriteKey"
$inheritance = [System.Security.AccessControl.InheritanceFlags]"None"
$propagation = [System.Security.AccessControl.PropagationFlags]"None"
$type = [System.Security.AccessControl.AccessControlType]"Deny"
$rule = New-Object System.Security.AccessControl.RegistryAccessRule( `
  $person,$access,$inheritance,$propagation,$type)
$acl.RemoveAccessRule($rule)
Set-Acl HKCU:\Software\Testkey $acl -force
```

However, removing your access rule may not work the way you expect because you have now locked yourself out. Because you no longer have the right to modify the key, that also applies to changes to your security settings. You can correct the problem only if you take ownership of the key. If this occurs, open the registry editor, navigate to the key, and by right-clicking and then selecting *Permissions* open the security dialog box and manually remove the entry for *Everyone*.

You've just seen how easy it is to lock yourself out. Be especially careful when you work with the *Everyone* group, where, if at all possible, you should employ no restrictions because they often have far greater consequences than you would like.

Controlling Access to Subkeys

In the next example, you can do things better and use rules not on restrictions but on permissions. In the following test key, only administrators are supposed to be able to modify the values of the key. However, all others, may read the key:

```
md HKCU:\Software\Testkey2
$acl = Get-Acl HKCU:\Software\Testkey2
# Admins may do everything:
$person = [System.Security.Principal.NTAccount]"Administrators"
$access = [System.Security.AccessControl.RegistryRights]"FullControl"
$inheritance = [System.Security.AccessControl.InheritanceFlags]"None"
$propagation = [System.Security.AccessControl.PropagationFlags]"None"
$type = [System.Security.AccessControl.AccessControlType]"Allow"
$rule = New-Object System.Security.AccessControl.RegistryAccessRule( `
  $person,$access,$inheritance,$propagation,$type)
$acl.ResetAccessRule($rule)
# Everyone may only read and create subkeys:
$person = [System.Security.Principal.NTAccount]"Everyone"
$access = [System.Security.AccessControl.RegistryRights]"ReadKey"
$inheritance = [System.Security.AccessControl.InheritanceFlags]"None"
$propagation = [System.Security.AccessControl.PropagationFlags]"None"
$type = [System.Security.AccessControl.AccessControlType]"Allow"
$rule = New-Object System.Security.AccessControl.RegistryAccessRule( `
  $person,$access,$inheritance,$propagation,$type)
$acl.ResetAccessRule($rule)
```

```
Set-Acl HKCU:\Software\Testkey2 $acl
```

Note that in this case the new rules were not entered by using *AddAccessRule()* but by *ResetAccessRule()*. This results in removal of all existing permissions for respective users. Nevertheless, the result still isn't right because normal users can still create subkeys in the key and write values:

```
md hkcu:\software\Testkey2\Subkey

  Hive: Microsoft.PowerShell.Core\Registry::HKEY_CURRENT_USER\software\Testkey2
  SKC  VC Name                      Property
  ---  -- ----                      --------
    0   0 Subkey                    {}

Set-ItemProperty HKCU:\Software\Testkey2 Value1 "Here is text"
```

Revealing Inheritance

Look at the current permissions of the key: to determine why your permissions may not be working the way you planned:

```
(Get-Acl HKCU:\Software\Testkey2).Access | Format-Table -wrap

  Registry Access  IdentityReference IsInhe  InheritanceFlags   Propagat
  Rights   Control                   rited                      ionFlags
           Type
  -------- ------- ----------------- ------ -----------------   --------
   ReadKey   Allow Everyone           False              None       None
  FullCont   Allow BUILT-IN\          False              None       None
       rol         Administrators
  FullCont   Allow TobiasWeltner-PC\   True ContainerInherit,       None
       rol         Tobias Weltner                ObjectInherit
  FullCont   Allow NT AUTHORITY\       True ContainerInherit,       None
       rol         SYSTEM                        ObjectInherit
  FullCont   Allow BUILT-IN\           True ContainerInherit,       None
       rol         Administrators                ObjectInherit
   ReadKey   Allow NT AUTHORITY\       True ContainerInherit,       None
                   RESTRICTED ACCESS             ObjectInherit
```

The key includes many more permissions than what you assigned to it so it gets these additional permissions by inheritance from parent keys. If you want to turn off inheritance, use *SetAccessRuleProtection()*:

```
$acl = Get-Acl HKCU:\Software\Testkey2
$acl.SetAccessRuleProtection($true, $false)
Set-Acl HKCU:\Software\Testkey2 $acl
```

Now, when you look at the permissions, the key will contain only the permissions that you explicitly set so it no longer inherits any permissions from parent keys:

```
(Get-Acl HKCU:\Software\Testkey2).Access | Format-Table -wrap

  Registry Access   IdentityReference IsInhe  InheritanceFlags  Propagat
  Rights   Control                    rited                     ionFlags
           Type
  -------- -------- ----------------- ------ -----------------  --------
   ReadKey    Allow Everyone           False              None      None
  FullCont    Allow BUILT-IN\          False              None      None
       rol          Administrators
```

Controlling Your Own Inheritance

Inheritance is a sword that cuts both ways. You have just turned off the inheritance of permissions from parent keys, but what about your own inheritance permissions? Launch a PowerShell console with administrator privileges so that you can create additional subkeys for your protected key:

```
md HKCU:\Software\Testkey2\Subkey1
md HKCU:\Software\Testkey2\Subkey1\Subkey2
```

Then take a look at the permissions for these new subkeys:

```
 (Get-Acl HKCU:\Software\Testkey2\Subkey1\Subkey2).Access | Format-Table -wrap

  Registry Access   IdentityReference IsInhe  InheritanceFlags  Propagat
  Rights   Control                    rited                     ionFlags
           Type
  -------- -------- ----------------- ------ -----------------  --------
  FullCont    Allow NT AUTHORITY\      False              None      None
       rol          SYSTEM
  FullCont    Allow BUILT-IN\          False              None      None
       rol          Administrators
  CreateLi    Allow S-1-5-5-0-344927   False              None      None
  nk, Read
  Key
```

The result doesn't correspond to the access permissions that you set. The reason: you specified *None* as inheritance. If you want to pass on your permissions to subdirectories, change the setting:

```
del HKCU:\Software\Testkey2
md HKCU:\Software\Testkey2
$acl = Get-Acl HKCU:\Software\Testkey2
# Admins may do anything:
$person = [System.Security.Principal.NTAccount]"Administrators"
$access = [System.Security.AccessControl.RegistryRights]"FullControl"
$inheritance = [System.Security.AccessControl.InheritanceFlags]`
"ObjectInherit,ContainerInherit"
$propagation = [System.Security.AccessControl.PropagationFlags]"None"
$type = [System.Security.AccessControl.AccessControlType]"Allow"
$rule = New-Object System.Security.AccessControl.RegistryAccessRule( `
  $person,$access,$inheritance,$propagation,$type)
```

```
$acl.ResetAccessRule($rule)
# Everyone may only read and create subkeys:
$person = [System.Security.Principal.NTAccount]"Everyone"
$access = [System.Security.AccessControl.RegistryRights]"ReadKey"
$inheritance = [System.Security.AccessControl.InheritanceFlags]`
"ObjectInherit,ContainerInherit"
$propagation = [System.Security.AccessControl.PropagationFlags]"None"
$type = [System.Security.AccessControl.AccessControlType]"Allow"
$rule = New-Object System.Security.AccessControl.RegistryAccessRule( `
  $person,$access,$inheritance,$propagation,$type)
$acl.ResetAccessRule($rule)
Set-Acl HKCU:\Software\Testkey2 $acl
```

CHAPTER 17.

Processes, Services, Event Logs

In your daily work as an administrator, you often have to deal with programs (processes), services, and innumerable entries in event logs so this is a good opportunity to put into practice the basic knowledge you gained from the first 12 chapters. The examples and topics covered in this chapter are meant to give you an idea of the full range of options.

In the course of your reading, you will no doubt rack your brains occasionally and find yourself flipping back pages to the introductory chapters. What's really astonishing are the many and diverse options you have in using the PowerShell pipeline (as discussed in Chapter 5) and associated formatting cmdlets to wring out every last bit of data from pipeline objects. What was just dry theory in Chapter 5 will now become very interesting in the following.

Topics Covered:

Processes

Processes are basically running programs as most routine tasks can be mastered using the cmdlets *Get-Process* and *Stop-Process*. In addition, processes can also be controlled directly by the objects and methods of the .NET framework.

Starting Processes

Starting processes is inherent in the console. You can launch any executable program in a directory named in the PATH environment variable simply by typing its name:

```
notepad
regedit
```

```
explorer .
```

But note how PowerShell loses control over Windows applications. After applications start, they are left to their own devices since PowerShell can't directly access these processes once they've started. Direct control of a process is only possible if you start the process using the *Start()* .NET method, which enables you to check whether a process still responds or is terminated. You can also force a process to stop running:

```
$process = [System.Diagnostics.Process]::Start("notepad")
$process.Responding

  True

$process.HasExited

  False

$process.Kill()
```

You can even use *WaitForExit()* to get PowerShell to wait until the process exits, which comes in handy inside PowerShell scripts when you want to make sure that a process has completed its task before you go on to the next step:

```
$process = [System.Diagnostics.Process]::Start("notepad")
$process.WaitForExit()
```

Monitoring Processes

Get-Process retrieves all running processes. What applies here applies in general to PowerShell: the cmdlet retrieves *Process* objects as result, not text. Text will appear only if you output the result of *Get-Process* to the console:

```
# Output all processes beginning with "P":
Get-Process p*

  Handles  NPM(K)   PM(K)   WS(K)   VM(M)   CPU(s)     Id ProcessName
  -------  ------   -----   -----   -----   ------     -- -----------
      377       8   21224   13344     167     1,84   7144 powershell
      184       7   10328    9528      85     2,28   5652 PSDrt
```

Each *Process* object contains more information than is displayed in the console. To view all properties, send the result to a formatting cmdlet like *Format-List* and append with an asterisk:

```
Get-Process powershell | Format-List *

  __NounName                 : Process
  Name                       : powershell
  Handles                    : 377
  VM                         : 175292416
  WS                         : 13664256
```

```
PM                         : 21733376
NPM                        : 8268
Path                       : C:\WINDOWS\system32\WindowsPowerShell\
                             v1.0\powershell.exe
Company                    : Microsoft Corporation
CPU                        : 1,8408118
FileVersion                : 6.0.6000.16386 (winmain(wmbla).070112-1312)
ProductVersion             : 6.0.6000.16386
Description                : PowerShell.EXE
Product                    : Microsoft® Windows® PowerShell
Id                         : 7144
PriorityClass              : Normal
HandleCount                : 377
WorkingSet                 : 13664256
PagedMemorySize            : 21733376
PrivateMemorySize          : 21733376
VirtualMemorySize          : 175292416
TotalProcessorTime         : 00:00:01.8408118
BasePriority               : 8
ExitCode                   :
HasExited                  : False
ExitTime                   :
Handle                     : 1648
MachineName                : .
MainWindowHandle           : 1774772
MainWindowTitle            : Windows PowerShell
MainModule                 : System.Diagnostics.ProcessModule
                             (powershell.exe)
MaxWorkingSet              : 1413120
MinWorkingSet              : 204800
Modules                    : {powershell.exe, ntdll.dll, kernel32.dll,
                             ADVAPI32.dll...}
NonpagedSystemMemorySize   : 8268
NonpagedSystemMemorySize64 : 8268
PagedMemorySize64          : 21733376
PagedSystemMemorySize      : 137688
PagedSystemMemorySize64    : 137688
PeakPagedMemorySize        : 43565056
PeakPagedMemorySize64      : 43565056
PeakWorkingSet             : 32870400
PeakWorkingSet64           : 32870400
PeakVirtualMemorySize      : 195878912
PeakVirtualMemorySize64    : 195878912
PriorityBoostEnabled       : True
PrivateMemorySize64        : 21733376
PrivilegedProcessorTime    : 00:00:00.5928038
ProcessName                : powershell
ProcessorAffinity          : 3
Responding                 : True
SessionId                  : 1
StartInfo                  : System.Diagnostics.ProcessStartInfo
StartTime                  : 16.10.2007 13:32:55
SynchronizingObject        :
```

```
Threads                    : {6584, 6816, 7032, 6412}
UserProcessorTime          : 00:00:01.2480080
VirtualMemorySize64        : 175292416
EnableRaisingEvents        : False
StandardInput              :
StandardOutput             :
StandardError              :
WorkingSet64               : 13664256
Site                       :
Container                  :
```

Filtering and Clearly Displaying Processes

As described in Chapter 5, you can use pipeline filters to work on lists of processes. If you were only interested in processes that have been running for less than three hours, you could find them like this:

```
Get-Process | Where-Object { $_.StartTime -gt `
  (Get-Date).AddMinutes(-180) } | Format-Table

   Handles  NPM(K)  PM(K)   WS(K)  VM(M)  CPU(s)    Id  ProcessName
   -------  ------  -----   -----  -----  ------    --  -----------
       671      75  50944   41392    316   13,96  4408  devenv
       571      29  60180   40824    213   71,09  8076  iexplore
        51       3   1248    5468     56    0,19  5932  notepad
       411      17  69892   54936    291   27,42  7224  PowerShellPlus.vshost
       110       3   3072    5320     54    0,06  1508  SearchFilterHost
       303       6   5136    8668     69    0,09  7096  SearchProtocolHost
       844      35  50480  107004    381  141,02  6460  WINWORD
```

If you want start times displayed, append the property you seek to *Format-Table*. As shown in Chapter 5, the next statement adds a new *Minutes* column that calculates the elapsed time in minutes since a program began running:

```
Get-Process | Where-Object { $_.StartTime -gt (Get-Date).AddMinutes(-180) } |
Format-Table Name, Id, StartTime, @{expression={ [int](New-TimeSpan `
$_.StartTime (get-date) ).TotalMinutes }; label="Minutes" } -autosize

   Name                    Id StartTime           Minutes
   ----                    -- ---------           -------
   devenv                4408 10.16.2007 16:06:42     129
   iexplore              8076 10.16.2007 16:15:48     119
   notepad               5932 10.16.2007 17:35:16      40
   PowerShellPlus.vshost 7224 10.16.2007 16:32:26     103
   SearchFilterHost      4584 10.16.2007 18:14:21       1
   SearchProtocolHost    7884 10.16.2007 18:14:21       1
   taskeng               2864 10.16.2007 18:11:55       3
   WINWORD               6460 10.16.2007 17:29:01      46
```

pro tip

Use the option described in Chapter 5: with *Format-Table* or *Format-List* to output calculated columns. This allows you to select from current properties of a *Process* object, as well as properties of child objects, and you can also obtain or calculate entirely new data.

In the following example, *Get-Process* returns for each process not only its name but also the directory from which the process was started, as well as a description of the process. The start directory is a property of a child object in *MainModule*. The static .NET method *GetVersionInfo()* will obtain a description of the process if it is given the path of the process. That can be found in the *Path* property:

```
Get-Process | Format-Table Name, @{ex={ $_.MainModule.FileName };
la="StartDirectory"},
@{ex={([system.diagnostics.fileversioninfo]::`
GetVersionInfo($_.Path)).FileDescription}; la="Description"} -wrap

  Name           StartDirectory              Description
  ----           ------------                -------------
  agrsmsvc       C:\Windows\system32\        Agere Soft Modem Call
                 agrsmsvc.exe                Progress Service
  AppSvc32       C:\Program Files\Common     Symantec Application
                 Files\Symantec Shared\App   Core Service
                 Core\AppSvc32.exe
  Ati2evxx       C:\Windows\system32\        ATI External Event
                 Ati2evxx.exe                Utility EXE Module
  ATSwpNav       C:\Program Files\Finger     ATSwpNav Application
                 print Sensor\ATSwpNav
                 .exe
  BatteryMiser5  C:\Program Files\LG         Battery Miser
                 Software\Battery Miser\
                 BatteryMiser5.exe
  ccApp          C:\Program Files\Common     Symantec User Session
                 Files\Symantec Shared\
                 ccApp.exe
  (...)
```

Counting Processes

Processes can be counted rather easily because the result of *Get-Process* is (nearly) always an array, which comes with the *Count* property. *Get-Process* won't necessarily return the result as an array; only if the result is a single process or no process at all. That's why you should always first convert the result into an array before you determine the number of array elements:

```
# Determine the number of notepads:
@(Get-Process notepad).Count
1
```

Another sort of "measurement" is carried out by *Measure-Object*. It makes a statistical evaluation of a particular object property. For example, if you wanted to know what the minimum, maximum, and average values of the *PagedSystemMemorySize* property are, proceed as follows:

```
Get-Process | Measure-Object -Average -Maximum `
-Minimum -Property PagedSystemMemorySize

  Count    : 112
  Average  : 86227,2857142857
  Sum      :
  Maximum  : 369472
  Minimum  : 0
  Property : PagedSystemMemorySize
```

Accessing Process Objects

Each *Process* object contains methods and properties. As discussed in detail in Chapter 6, many properties may be read as well as modified, and methods can be executed like commands. This allows you to control many fine settings of processes. For example, you can specifically raise or lower the priority of a process. The next statement lowers the priority of all Notepads:

```
Get-Process notepad |
  ForEach-Object { $_.PriorityClass = "BelowNormal" }
```

Stopping Processes

You can use *Stop-Process* to stop running processes, but that can be risky because PowerShell makes it so very easy to do. The following statement closes all opened Notepads and does so without asking for confirmation—even when the Notepads contain unsaved text:

```
Stop-Process -name Notepad
```

However, a small safety measure is integrated that forces you to specify the *-name* parameter. The standard parameter that you can use even without a parameter name is for *Stop-Process* the process ID.

tip

Use the *-whatif* option for *Stop-Process* to check in advance what the command would do. Use *-confirm* when you want to have each step confirmed to avoid risks.

Services

Services are special programs, which are executed unsupervised and require no interactive logon session. Services provide functions usually not linked to any individual user. You should use the following PowerShell cmdlets to manage services:

Cmdlet	**Description**
Get-Service	Lists services
New-Service	Registers a service
Restart-Service	Stops a service and then restarts it. For example, to allow modifications of settings to take effect
Resume-Service	Resumes a stopped service
Set-Service	Modifies settings of a service
Start-Service	Starts a service
Stop-Service	Stops a service
Suspend-Service	Suspends a service

Table 17.1: Cmdlets for managing services

Listing Services

Get-Service works like *Get-Process* and *Get-ChildItem*: it returns service objects that meet your criterion. All services will be listed if you don't specify any criterion. Use *Where-Object* in the pipeline if you want to filter the result:

```
# List all services beginning with "A":
Get-Service a*
# Only running services beginning with "A":
Get-Service a* | Where-Object { $_.status -eq 'Running' }


  Status   Name               DisplayName
```

```
------   ----              -----------
Running  AeLookupSvc       Application Experience Lookup
Running  AgereModemAudio   Agere Modem Call Progress Audio
Running  Appinfo           Application information
Running  Ati External Ev... Ati External Event Utility
Running  AudioEndpointBu... Windows Audio Endpoint Builder
Running  Audiosrv          Windows Audio
```

Starting, Stopping, Suspending, Resuming Services

To start, stop, temporarily suspend, or restart a service, all you have to do is to clearly identify the service. *Get-Service* will retrieve the service for you, which you can then pass on to one of the other cmdlets listed in Table 17.1.

important

Most services perform important tasks. Be cautious when you stop or start services. Pick out a harmless service, and if you're not sure whether a service is harmless, it's wiser not to experiment.

For example, the following statement stops the service called *Parental Controls* on Windows Vista. Of course, this will only work if you have administrator rights (and the service has to be running as well):

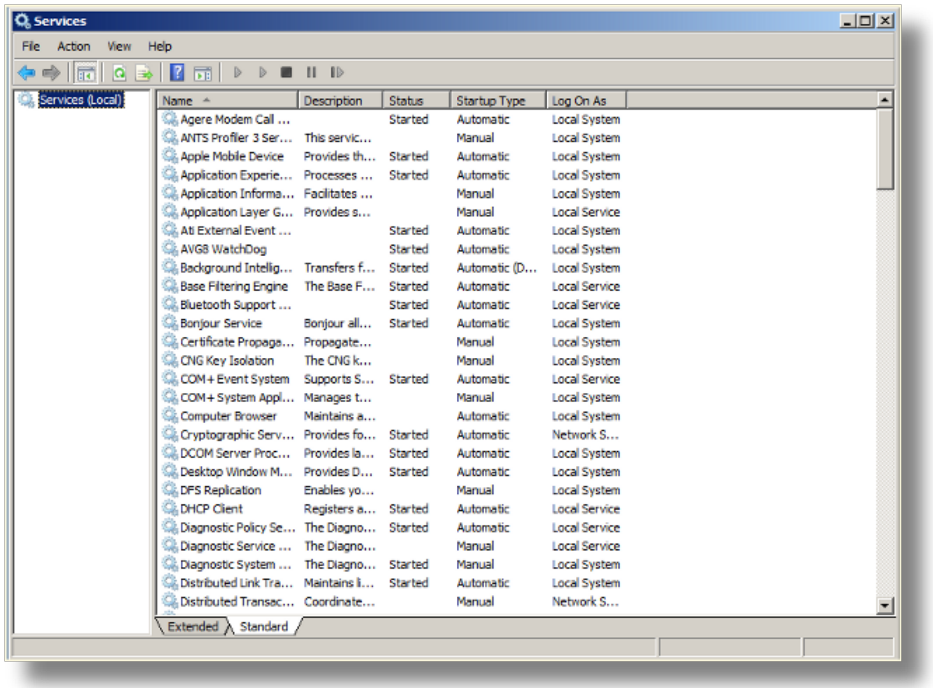
```
Get-Service | Where-Object { $_.DisplayName -eq `
'Parental Controls' } | Stop-Service

  Stop-Service : Service "Parental Controls (WPCSvc)"
  cannot be stopped due to the following error: Cannot
  stop WPCSvc service on computer '.'.
  At line:1 char:79
  + Get-Service | Where-Object { $_.DisplayName -eq
  'Parental Controls' } | Stop-Service <<<<
```

tip

Use the *DisplayName* property if you want to identify a service by its language-localized name. Be absolutely sure that the service name is enclosed in single and not double quotation marks, because some service names include the "$" character. If the character is in text wrapped in double quotation marks, PowerShell will automatically recognize it as identifying a variable and remove it. Start it if you want to track the consequences of your Windows services snap-in modifications:

```
services.msc
```

But don't forget to refresh your display because it lags behind and will not display your current changes.



Name	Description	Status	Startup Type	Log On As
Agere Modem Call ...		Started	Automatic	Local System
ANTS Profiler 3 Ser...	This servic...		Manual	Local System
Apple Mobile Device	Provides th...	Started	Automatic	Local System
Application Experie...	Processes ...	Started	Automatic	Local System
Application Informa...	Facilitates ...		Manual	Local System
Application Layer G...	Provides s...		Manual	Local Service
Ati External Event ...		Started	Automatic	Local System
AVG8 WatchDog		Started	Automatic	Local System
Background Intellig...	Transfers f...	Started	Automatic (D...	Local System
Base Filtering Engine	The Base F...	Started	Automatic	Local Service
Bluetooth Support ...		Started	Automatic	Local Service
Bonjour Service	Bonjour all...	Started	Automatic	Local System
Certificate Propaga...	Propagate...		Manual	Local System
CNG Key Isolation	The CNG k...		Manual	Local System
COM+ Event System	Supports S...	Started	Automatic	Local Service
COM+ System Appl...	Manages t...		Manual	Local System
Computer Browser	Maintains a...		Automatic	Local System
Cryptographic Serv...	Provides fo...	Started	Automatic	Network S...
DCOM Server Proc...	Provides la...	Started	Automatic	Local System
Desktop Window M...	Provides D...	Started	Automatic	Local System
DFS Replication	Enables yo...		Manual	Local System
DHCP Client	Registers a...	Started	Automatic	Local Service
Diagnostic Policy Se...	The Diagno...	Started	Automatic	Local Service
Diagnostic Service ...	The Diagno...		Manual	Local Service
Diagnostic System ...	The Diagno...	Started	Manual	Local System
Distributed Link Tra...	Maintains li...	Started	Automatic	Local System
Distributed Transac...	Coordinate...		Manual	Network S...

Figure 17.1: Use the services snap-in to check your modifications

Event Log

Windows makes records of all malfunctions, warnings, and other information in its event logs. You can use the *Get-Eventlog* cmdlet to access log entries. That's a prudent thing to do because event logs are jam-packed with information, and PowerShell is absolutely the right tool to extract the important information they contain.

Use the *-list* parameter to find out what event logs are on your system. The *Entries* column should already give you a rough idea of how much information is being collected in some of your event logs:

```
Get-EventLog -List

    Max(K) Retain OverflowAction        Entries Name
    ------ ------ --------------        ------- ----
       512      7 OverwriteOlder            659 ACEEventLog
    20,480      0 OverwriteAsNeeded      21,032 Application
    15,168      0 OverwriteAsNeeded           0 DFS Replication
    20,480      0 OverwriteAsNeeded           0 Microsoft-Windows-
                                                Forwarding/Operational

       512      7 OverwriteOlder              0 Internet Explorer
       512      7 OverwriteOlder              0 Key Management Service
     8,192      0 OverwriteAsNeeded           0 Media Center
    16,384      0 OverwriteAsNeeded           8 Microsoft Office
```

```
                                                 Diagnostics
      16,384      0 OverwriteAsNeeded         524 Microsoft Office
                                                 Sessions
      20,480      0 OverwriteAsNeeded      61,829 System
      15,360      0 OverwriteAsNeeded      18,465 Windows PowerShell
```

If you wanted to get a display of all the entries in the *System* log, you would no doubt agree that there's just too much information to be helpful:

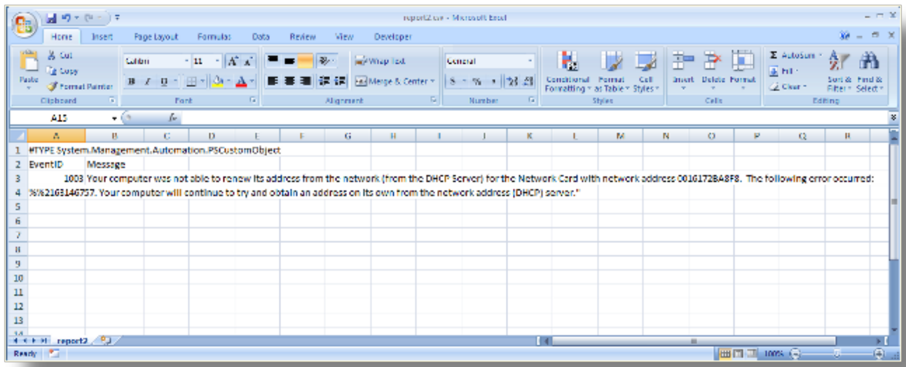
```
Get-EventLog System

  Index Time          Type Source        EventID Message
  ----- ----          ---- ------        ------- -------
  ...81 Oct 16 19:02  Info Service ...   7036 The description for...
  ...80 Oct 16 18:59  Info Service ...   7036 The description for...
  ...79 Oct 16 18:59  Info Tcpip         4201 Network adapter "wi...
  ...78 Oct 16 18:59  Info Tcpip         4201 Network adapter "wi...
  ...77 Oct 16 18:59  Info Dhcp          1103 Network address was...
  ...76 Oct 16 18:59  Info BROWSER       8033 Search service has ...
  ...75 Oct 16 18:45  Info Service ...   7036 The description for...
  ...74 Oct 16 18:29  Info Service ...   7036 The description for...
  ...73 Oct 16 18:29  Info Tcpip         4201 Network adapter "wi...
```

That's why you should use the PowerShell filters. Use Where-*Object* to pass the information retrieved by *Get-Eventlog* through the pipeline while allowing only those entries through that meet your criteria. The next statement reads only those events from the PowerShell event log that match the type, "Information", and have today's date. To do so, PowerShell compares the contents of the *TimeWritten*property with today's date. Since only the date, and not the time, are supposed to be compared, PowerShell compares the result of *Date()*, a method of the *DateTime* type that sets the time to zero.

```
Get-Eventlog "Windows PowerShell" |
Where-Object {$_.EntryType -eq "Information"} |
Where-Object {($_.TimeWritten).Date -eq (Get-Date).Date}

  Index Time          Type Source       EventID Message
  ----- ----          ---- ------       ------- -------
  60339 Oct 16 16:32  Info PowerShell       400 Engine state is cha...
  60338 Oct 16 16:32  Info PowerShell       600 Provider "Certifica...
  60337 Oct 16 16:32  Info PowerShell       600 Provider "Variable"...
  60336 Oct 16 16:32  Info PowerShell       600 Provider "Registry"...
  60335 Oct 16 16:32  Info PowerShell       600 Provider "Function"...
  60334 Oct 16 16:32  Info PowerShell       600 Provider "FileSyste...
  60333 Oct 16 16:32  Info PowerShell       600 Provider "Environme...
  60332 Oct 16 16:32  Info PowerShell       600 Provider "Alias" is...
  60331 Oct 16 16:27  Info PowerShell       400 Engine state is cha...
  60330 Oct 16 16:27  Info PowerShell       600 Provider "Certifica...
  60329 Oct 16 16:27  Info PowerShell       600 Provider "Variable"...
  (...)
```

Access to the event logs is easy, but it's a more difficult matter to find your way around the information in the logs and to create the right filters to extract the right information. However, once you have mastered that, you can process information in Excel by using *Export-Csv*:

```
Get-Eventlog "System" |
Where-Object {$_.EntryType -eq "Warning"} |
Where-Object {($_.TimeWritten).Date -eq (Get-Date).Date} |
Select-Object EventID, Message |
Export-Csv report2.csv
.\report2.csv
```



```
#TYPE System.Management.Automation.PSCustomObject
EventID    Message
      1003 Your computer was not able to renew its address from the network (from the DHCP Server) for the Network Card with network address 0016172BA8F8.  The following error occurred:
%%2163146757. Your computer will continue to try and obtain an address on its own from the network address (DHCP) server."
```

Figure 17.2: Picking out PowerShell events and exporting them to Excel

tip

For PowerShell, filtering event logs takes place mostly on the client side, so access is slow and ineffective. In the case of huge event logs, all their results have to pass through the PowerShell pipeline. The Windows Management Instrumentation (WMI) service, which you will use in another chapter, is better at managing event logs since it filters events on the server side.

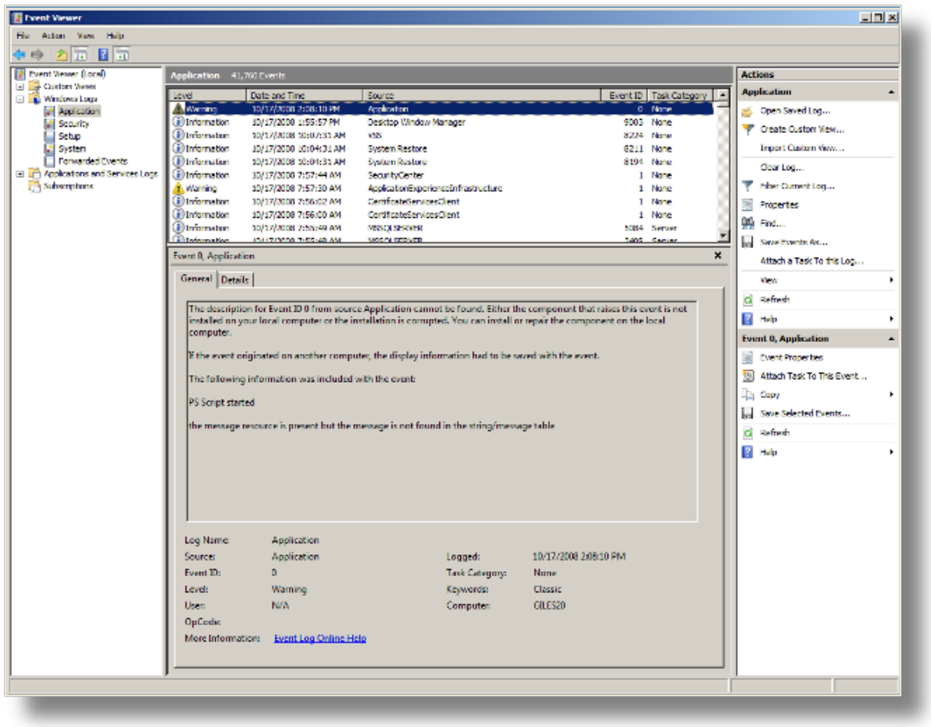
Writing Entries to the Event Log

PowerShell officially supports only the reading of events. However, since you can always resort to the methods of the .NET framework, making your own entries is no problem:

```
[Diagnostics.EventLog]::WriteEntry("Application","PS Script started","Warning")
```

The Event Viewer shows you that it was successful:

```
eventvwr.msc
```



Application 41,760 Events

Level	Date and Time	Source	Event ID	Task Category
Warning	10/17/2008 2:08:10 PM	Application	0	None
Information	10/17/2008 1:55:57 PM	Desktop Window Manager	9003	None
Information	10/17/2008 10:07:31 AM	VSS	8224	None
Information	10/17/2008 10:04:31 AM	System Restore	8211	None
Information	10/17/2008 10:04:31 AM	System Restore	8194	None
Information	10/17/2008 7:57:44 AM	SecurityCenter	1	None
Warning	10/17/2008 7:57:30 AM	ApplicationExperienceInfrastructure	1	None
Information	10/17/2008 7:56:02 AM	CertificateServicesClient	1	None
Information	10/17/2008 7:56:00 AM	CertificateServicesClient	1	None
Information	10/17/2008 7:55:49 AM	MSSQLSERVER	5084	Server

Event 0, Application

General | Details

The description for Event ID 0 from source Application cannot be found. Either the component that raises this event is not installed on your local computer or the installation is corrupted. You can install or repair the component on the local computer.

If the event originated on another computer, the display information had to be saved with the event.

The following information was included with the event:

PS Script started

the message resource is present but the message is not found in the string/message table

Log Name:	Application		
Source:	Application	Logged:	10/17/2008 2:08:10 PM
Event ID:	0	Task Category:	None
Level:	Warning	Keywords:	Classic
User:	N/A	Computer:	GILES20
OpCode:			
More Information:	Event Log Online Help		

Figure 17.3: Events you make may look a little strange

What happened here is that the event you made was properly written, but because you aren't known as an event log source, the event display is hard to understand.

CHAPTER 18.

WMI: Windows Management Instrumentation

It might have escaped your attention, but the Windows Management Instrumentation (WMI) service introduced with Windows 2000 has been part of every Windows version since then. The WMI service is important because it can retrieve information about nearly every aspect of your system and can even make some modifications. However, it would be beyond the scope of this book to go into WMI in greater depth because that alone could fill another volume. For this reason, we will focus on how the WMI service basically works and how PowerShell handles it.

Topics Covered:

WMI Classes and Instances

WMI represents the insides of your computer in the form of classes. WMI provides classes for nearly everything: processor, BIOS, memory, user accounts, services, etc. The name of a class usually consists of the "Win32" prefix and the English-language name of what that class is meant to describe. For example, the *Win32_Service* describes services.

Instances of a Class

If you already know the name of a WMI class, *Get-WmiObject* will retrieve all instances of the class for you:

```
Get-WmiObject Win32_BIOS

  SMBIOSBIOSVersion : RKYWSF21
  Manufacturer      : Phoenix Technologies LTD
  Name              : Phoenix TrustedCore(tm) NB Release SP1 1.0
  SerialNumber      : 701KIXB007922
  Version           : PTLTD  - 6040000
```

If you can't remember the name of a WMI class, use the *-list* parameter:

```
Get-WmiObject -list

  (...)
  Win32_HeatPipe              CIM_Refrigeration
  Win32_Refrigeration         CIM_Fan
  Win32_Fan                   CIM_Printer
  Win32_Printer               CIM_Controller
  CIM_ManagementController    CIM_SCSIController
  Win32_SCSIController        CIM_InfraredController
  Win32_InfraredDevice        CIM_PCIController
  (...)
```

tip

You'll then get a list of all the WMI classes of the current namespaces. The list can be very long. The class names don't all begin with "Win32_". Classes that begin with an underline character are designated for internal purposes and would seldom be useful to you. Classes that begin with "CIM" are usually basic classes. Specialized classes derived from these begin with "Win32" and are more appropriate. So, if you're looking for a particular class, focus on class names that begin with "Win32". Here's a simple way to find all WMI classes that have anything to do with the subject of "printing":

```
Get-WmiObject -list | Select-String -InputObject { $_.Name }
Win32_Print*

  Win32_PrinterConfiguration
  Win32_PrinterSetting
  Win32_PrintJob
  Win32_Printer
  Win32_PrinterDriver
  Win32_PrinterShare
  Win32_PrinterDriverDll
  Win32_PrinterController
```

Displaying All Properties

Often, only the most important properties of instances are displayed. You may remember the reason why from Chapter 5 and only if you want to display all properties. Specify one of the formatting cmdlets with an asterisk:

```
Get-WmiObject Win32_BIOS | Format-List *

  Status                  : OK
  Name                    : Phoenix TrustedCore(tm) NB Release SP1 1.0
  Caption                 : Phoenix TrustedCore(tm) NB Release SP1 1.0
  SMBIOSPresent           : True
  __GENUS                 : 2
  __CLASS                 : Win32_BIOS
  __SUPERCLASS            : CIM_BIOSElement
  __DYNASTY               : CIM_ManagedSystemElement
  __RELPATH               : Win32_BIOS.Name="Phoenix TrustedCore(tm) NB
                            Release SP1 1.0",SoftwareElementID="Phoenix
                            TrustedCore(tm) NB Release SP1 1.0",Software
                            ElementState=3,TargetOperatingSystem=0,Versi
                            on="PTLTD  - 6040000"
  __PROPERTY_COUNT        : 27
  __DERIVATION            : {CIM_BIOSElement, CIM_SoftwareElement, CIM_L
                            ogicalElement, CIM_ManagedSystemElement}
  __SERVER                : JSMITH-PC
  __NAMESPACE             : root\cimv2
  __PATH                  : \\JSMITH-PC\root\cimv2:Win32_BIOS.Name="Phoen
                            ix TrustedCore(tm) NB Release SP1 1.0",Softwa
                            reElementID="Phoenix TrustedCore(tm) NB Relea
                            se SP1 1.0",SoftwareElementState=3,TargetOper
                            atingSystem=0,Version="PTLTD  - 6040000"
  BiosCharacteristics     : {4, 7, 8, 9...}
  BIOSVersion             : {PTLTD  - 6040000, Phoenix TrustedCore(tm) NB
                            Release SP1 1.0, Ver 1.00PARTTBL}
  BuildNumber             :
  CodeSet                 :
  CurrentLanguage         :
  Description             : Phoenix TrustedCore(tm) NB Release SP1 1.0
  IdentificationCode      :
  InstallableLanguages    :
  InstallDate             :
  LanguageEdition         :
  ListOfLanguages         :
  Manufacturer            : Phoenix Technologies LTD
  OtherTargetOS           :
  PrimaryBIOS             : True
  ReleaseDate             : 20061110000000.000000+000
  SerialNumber            : 701KIXB007922
  SMBIOSBIOSVersion       : RKYWSF21
  SMBIOSMajorVersion      : 2
  SMBIOSMinorVersion      : 4
  SoftwareElementID       : Phoenix TrustedCore(tm) NB Release SP1 1.0
  SoftwareElementState   : 3
  TargetOperatingSystem  : 0
  Version                : PTLTD  - 6040000
```

Filtering Out PowerShell Properties

PowerShell binds to every WMI object a number of properties that begin with a double underline character but aren't actually part of the object. PowerShell uses these additional properties to manage WMI objects, something that will become very important a little later on in connection with the PowerShell *Extended Type System*. You can filter out any additional properties that distract you:

```
Get-WmiObject Win32_BIOS | Format-List [a-z]*
```

Now only those properties will be displayed that begin with a letter.

Selecting Particular Instances

It's seldom that you'll find a real use for all instances of a class. That's why you should use filters. The simplest (and slowest) filter is PowerShell itself. By using *Where-Object*, you can make sure that only those instances that have certain properties will be listed, such as all processes that have a specific name:

```
Get-WmiObject Win32_Process |
Where-Object { $_.Name -eq 'powershell.exe' }
```

It would be more efficient to pass this filter directly to WMI so that WMI will return only the instances you wanted right from the outset. To do so, use the *-filter* parameter. The filter that you specify with this parameter is not in PowerShell code but in the WMI query language (WQL), which in turn borrows a great deal from the SQL database query language.

```
Get-WmiObject Win32_Process -filter 'name = "powershell.exe"'
```

In addition, you can use the *-query* parameter if you would like to choose which properties of the instance should be returned by WMI. The next line returns the *Caption* and *Commandline* properties for all processes beginning with the letter "*p*":

```
Get-WmiObject -query `
'select caption,commandline from Win32_Process where name like "p%"'
```

The result is hard to understand because PowerShell supplements every WMI object with additional internal properties. For this reason, pass it to *Format-Table* and specify the properties that you want to make visible:

```
Get-WmiObject -query `
'select caption,commandline from Win32_Process where name like "p%"' |
Format-Table [a-z]* -wrap

  Caption  CommandL Scope    Options  ClassPa Propert SystemP Qualifi
           ine                        th      ies     roperti ers
```

```
                                                              es
       -------  --------- -----    -------  -------- -------  -------- -------
       PowerShe "C:\Prog System.M System.M Win32_P {Captio {__GENU {dynami
       llPlus.e ram File anagemen anagemen rocess  n, Comm S, __CL c, Loca
       xe       s\Idera\ t.Manage t.Object         andLine ASS, __ le, pro
                PowerShe mentScop GetOptio         }       SUPERCL vider,
                llPlus\p e        ns                       ASS, __ UUID}
                owershel                                   DYNASTY
                lplus.ex                                   ...}
                e"
```

note

PowerShell supports the *[WmiSearcher]* type accelerator, which you can use to achieve basically the same thing you just did with the *-query* parameter:

```
$searcher = [WmiSearcher]"select caption,commandline from `
Win32_Process where name like 'p%'"
$searcher.Get() | Format-Table [a-z]* -wrap
```

Directly Accessing Instances

Every WMI instance has its own unique path. This path is important if you want to access a particular instance directly. The path of a WMI object is located in the *__PATH* property. First get a display of this property if you want to find out how the path of a specific object is structured:

```
Get-WmiObject Win32_Service | ForEach-Object { $_.__PATH }

    \\JSMITH-PC\root\cimv2:Win32_Service.Name="AeLookupSvc"
    \\JSMITH-PC\root\cimv2:Win32_Service.Name="AgereModemAudio"
    \\JSMITH-PC\root\cimv2:Win32_Service.Name="ALG"
    \\JSMITH-PC\root\cimv2:Win32_Service.Name="Appinfo"
    \\JSMITH-PC\root\cimv2:Win32_Service.Name="AppMgmt"
    \\JSMITH-PC\root\cimv2:Win32_Service.Name="Ati External Event Utility"
    \\JSMITH-PC\root\cimv2:Win32_Service.Name="AudioEndpointBuilder"
    \\JSMITH-PC\root\cimv2:Win32_Service.Name="Audiosrv"
    \\JSMITH-PC\root\cimv2:Win32_Service.Name="Automatic LiveUpdate - Scheduler"
    \\JSMITH-PC\root\cimv2:Win32_Service.Name="BFE"
    \\JSMITH-PC\root\cimv2:Win32_Service.Name="BITS"
    \\JSMITH-PC\root\cimv2:Win32_Service.Name="Browser"
    (...)
```

The path consists basically of the class name as well as one or more key properties. For services, the key property is *Name* and is the English-language name of the service. If you want to work directly with a particular service through WMI, specify its path and do a type conversion. Use either the *[wmi]* type accelerator or the underlying *[System.Management.ManagementObject]* .NET type:

```
[wmi]"Win32_Service.Name='Fax'"
```

```
    ExitCode  : 1077
    Name      : Fax
    ProcessId : 0
    StartMode : Manual
    State     : Stopped
    Status    : OK
```

In fact, you don't necessarily need to specify the name of the key property as long as you at least specify its value. This way, you'll find all the properties of a specific WMI instance right away.

```
  $disk = [wmi]'Win32_LogicalDisk="C:"'
  $disk.FreeSpace

    10181373952

  [int]($disk.FreeSpace / 1MB)

    9710

  $disk | Format-List [a-z]*

    Status                       :
    Availability                 :
    DeviceID                     : C:
    StatusInfo                   :
    Access                       : 0
    BlockSize                    :
    Caption                      : C:
    Compressed                   : False
    ConfigManagerErrorCode       :
    ConfigManagerUserConfig      :
    CreationClassName            : Win32_LogicalDisk
    Description                  : Local hard drive
    DriveType                    : 3
    ErrorCleared                 :
    ErrorDescription             :
    ErrorMethodology             :
    FileSystem                   : NTFS
    FreeSpace                    : 10181373952
    InstallDate                  :
    LastErrorCode                :
    MaximumComponentLength       : 255
    MediaType                    : 12
    Name                         : C:
    NumberOfBlocks               :
    PNPDeviceID                  :
    PowerManagementCapabilities  :
    PowerManagementSupported     :
    ProviderName                 :
    Purpose                      :
    QuotasDisabled               :
    QuotasIncomplete             :
```

```
    QuotasRebuilding             :
    Size                         : 100944637952
    SupportsDiskQuotas           : False
    SupportsFileBasedCompression : True
    SystemCreationClassName      : Win32_ComputerSystem
    SystemName                   : JSMITH-PC
    VolumeDirty                  :
    VolumeName                   :
    VolumeSerialNumber           : AC039C05
```

Modifying Properties

Most of the properties that you find in WMI objects are read-only. There are few, though, that can be modified. For example, if you want to change the description of a drive, add new text to the *VolumeName* property of the drive:

```
  $drive = [wmi]"Win32_logicaldisk='C:'"
  $drive.VolumeName = "My Harddrive"
  $drive.Put()

    Path          : \\.\root\cimv2:Win32_LogicalDisk.DeviceID="C:"
    RelativePath  : Win32_LogicalDisk.DeviceID="C:"
    Server        : .
    NamespacePath : root\cimv2
    ClassName     : Win32_LogicalDisk
    IsClass       : False
    IsInstance    : True
    IsSingleton   : False
```

Three conditions must be met before you can modify a property:

- The property must allow modifications in general. Most properties are read-only.
- You require the proper permissions for modifications. The drive description applies to all users of a computer so only administrators may modify them.
- You must use *Put()*to save the modification. Without *Put()*, the modification will not take effect.

Viewing Class Descriptions

Nearly every WMI class has a built-in description that explains its purpose. You can view this description only if you first set a hidden option called *UseAmendedQualifiers* to *$true*. Once that's done, the WMI class will readily supply information about its function:

```
  $class = [wmiclass]'Win32_LogicalDisk'
  $class.psbase.Options.UseAmendedQualifiers = $true
  ($class.psbase.qualifiers["description"]).Value

    The Win32_LogicalDisk class represents a data source
    that resolves to an actual local storage device on a
    Win32 system. The class returns both local as well as
    mapped logical disks. However, the recommended approach
    is to use this class for obtaining information on local
    disks and to use the Win32_MappedLogicalDisk for
    information on mapped logical disk.
```

In a similarly thorough way, all the properties of the class are documented. Look it up if you want to know the intended aim of the *VolumeDirty* property:

```
$class = [wmiclass]'Win32_LogicalDisk'
$class.psbase.Options.UseAmendedQualifiers = $true
$voldirty = $class.psbase.properties["VolumeDirty"]
$voldirty.Type

  Boolean

($voldirty.Qualifiers["Description"]).Value

  The VolumeDirty property indicates whether the disk
  requires chkdsk to be run at next boot up time. The
  property is applicable to only those instances of
  logical disk that represent a physical disk in the
  machine. It is not applicable to mapped logical
  drives.
```

Invoking WMI Methods

Basically, the same thing applies to WMI as it does to the .NET framework, and in Chapter 6 you learned that both classes and instances can provide methods, such as executable commands.

Instance-Based Methods

The instances of the *Win32_Process* class offer you, among other things, the *Terminate()* method with which you can force a process to stop running. To use *Terminate()*, you just need *Win32_Process* instances. *Get-WmiObject* can retrieve these for you. The next line ends all running Notepad instances. However, any unsaved work will be lost:

```
Get-WmiObject Win32_Process -filter "name='notepad.exe'" |
ForEach-Object { $_.Terminate() }
```

For every instance that *Terminate()* closes, it retrieves an object that is displayed in the console and that reports in *ReturnValue* whether the operation was carried out properly. If you want to verify its success, capture the object and inspect the *ReturnValue* property:

```
Get-WmiObject Win32_Process -filter "name='notepad.exe'" |
ForEach-Object {"Close all Notepads."; $good=0; $bad=0} {
  $result=$_.Terminate();
  if($result.ReturnValue -eq 0) {$good++} else {$bad++}
} { "Have closed $good instances. Problems arose in the `
case of $bad instances." }

  Close all Notepads.
  Have closed 2 instances. Problems arose in the case of 0 instances.
```

tip

If you already know the process ID of a process, you can work on the process directly just as you did in the last section because the process ID is the key property of processes. For example, you could terminate the process with the ID 1234 like this:

```
([wmi]"Win32_Process='1234'").Terminate()
```

If you'd rather check your hard disk drive C:\ for errors, the proper invocation is:

```
([wmi]"Win32_LogicalDisk='C:'").Chkdsk(...
```

However, since this method requires additional arguments, the question here is what you should specify. Invoke the method without parentheses in order to get initial brief instructions:

```
([wmi]"Win32_LogicalDisk='C:'").Chkdsk

  MemberType          : Method
  OverloadDefinitions : {System.Management.ManagementBaseObject
                        Chkdsk(System.Boolean FixErrors,
  System.
                        Boolean VigorousIndexCheck,
  System.Boole
                        an SkipFolderCycle, System.Boolean
  Force
                        Dismount, System.Boolean
  RecoverBadSecto
                        rs, System.Boolean OkToRunAtBootUp)}
  TypeNameOfValue     : System.Management.Automation.PSMethod
  Value               : System.Management.ManagementBaseObject
                        Chkdsk(System.Boolean FixErrors,
  System.
                        Boolean VigorousIndexCheck,
  System.Boole
                        an SkipFolderCycle, System.Boolean
  Force
                        Dismount, System.Boolean
  RecoverBadSecto
                        rs, System.Boolean OkToRunAtBootUp)
  Name                : Chkdsk
  IsInstance          : True
```

Listing Methods

Get-Member will tell you which methods a WMI object supports:

```
$object = Get-WmiObject Win32_Process |
  Select-Object -first 1
$object | Get-Member -memberType Method
```

```
   TypeName: System.Management.ManagementObject#
             root\cimv2\Win32_Process
   Name           MemberType Definition
   ----           ---------- ----------
   AttachDebugger Method     System.Management.Management
                             BaseObject AttachDebugger()
   GetOwner       Method     System.Management.Management
                             BaseObject GetOwner()
   GetOwnerSid    Method     System.Management.Management
                             BaseObject GetOwnerSid()
   SetPriority    Method     System.Management.Management
                             BaseObject SetPriority(System.
                             Int32 Priority)
   Terminate      Method     System.Management.Management
                             BaseObject Terminate(System.
                             UInt32 Reason)
```

Static Methods

A WMI class directly supplies static methods, very much like static methods of a .NET class. If you want to renew the IP addresses of all network cards, use the *Win32_NetworkAdapterConfiguration* class and its static method *RenewDHCPLeaseAll()*:

```
([wmiclass]"Win32_NetworkAdapterConfiguration").RenewDHCPLeaseAll()
```

You get the WMI class by using type conversion. You can either use the *[wmiclass]* type accelerator or the underlying *[System.Management.ManagementClass]* .NET type. *Get-Member* will again retrieve the methods of the class:

```
[wmiclass]"Win32_NetworkAdapterConfiguration" |
Get-Member -memberType Method
```

```
   TypeName: System.Management.ManagementClass#
             ROOT\cimv2\Win32_NetworkAdapterConfiguration
   Name                             MemberType Definition
   ----                             ---------- ----------
   EnableDNS                        Method     System.Management.Management
                                               BaseObject EnableDNS(System.
                                               String ...
   EnableIPFilterSec                Method     System.Management.Management
```

```
                                            BaseObject EnableIPFilterSec
                                            (System...
EnableWINS                        Method    System.Management.Management
                                            BaseObject EnableWINS(System
                                            .Boolea...
ReleaseDHCPLeaseAll               Method    System.Management.Management
                                            BaseObject ReleaseDHCPLeaseA
                                            ll()
RenewDHCPLeaseAll                 Method    System.Management.Management
                                            BaseObject RenewDHCPLeaseAll
                                            ()
SetArpAlwaysSourceRoute           Method    System.Management.Management
                                            BaseObject SetArpAlwaysSourc
                                            eRoute(...
SetArpUseEtherSNAP                Method    System.Management.Management
                                            BaseObject SetArpUseEtherSNA
                                            P(Syste...
SetDatabasePath                   Method    System.Management.Management
                                            BaseObject SetDatabasePath(S
                                            ystem.S...
SetDeadGWDetect                   Method    System.Management.Management
                                            BaseObject SetDeadGWDetect(S
                                            ystem.B...
SetDefaultTOS                     Method    System.Management.Management
                                            BaseObject SetDefaultTOS(Sys
                                            tem.Byt...
SetDefaultTTL                     Method    System.Management.Management
                                            BaseObject SetDefaultTTL(Sys
                                            tem.Byt...
SetDNSSuffixSearchOrder           Method    System.Management.Management
                                            BaseObject SetDNSSuffixSearc
                                            hOrder(...
SetForwardBufferMemory            Method    System.Management.Management
                                            BaseObject SetForwardBufferM
                                            emory(S...
SetIGMPLevel                      Method    System.Management.Management
                                            BaseObject SetIGMPLevel(Syst
                                            em.Byte...
SetIPUseZeroBroadcast             Method    System.Management.Management
                                            BaseObject SetIPUseZeroBroad
                                            cast(Sy...
SetIPXVirtualNetworkNumber        Method    System.Management.Management
                                            BaseObject SetIPXVirtualNetw
                                            orkNumb...
SetKeepAliveInterval              Method    System.Management.Management
                                            BaseObject SetKeepAliveInter
                                            val(Sys...
SetKeepAliveTime                  Method    System.Management.Management
                                            BaseObject SetKeepAliveTime(
                                            System....
SetMTU                            Method    System.Management.Management
                                            BaseObject SetMTU(System.UIn
                                            t32 MTU)
```

```
SetNumForwardPackets              Method     System.Management.Management
                                             BaseObject SetNumForwardPack
                                             ets(Sys...
SetPMTUBHDetect                   Method     System.Management.Management
                                             BaseObject SetPMTUBHDetect(S
                                             ystem.B...
SetPMTUDiscovery                  Method     System.Management.Management
                                             BaseObject SetPMTUDiscovery(
                                             System....
SetTcpMaxConnectRetransmissions Method       System.Management.Management
                                             BaseObject SetTcpMaxConnectR
                                             etransm...
SetTcpMaxDataRetransmissions      Method     System.Management.Management
                                             BaseObject SetTcpMaxDataRetr
                                             ansmiss...
SetTcpNumConnections              Method     System.Management.Management
                                             BaseObject SetTcpNumConnecti
                                             ons(Sys...
SetTcpUseRFC1122UrgentPointer     Method     System.Management.Management
                                             BaseObject SetTcpUseRFC1122U
                                             rgentPo...
SetTcpWindowSize                  Method     System.Management.Management
                                             BaseObject SetTcpWindowSize(
                                             System....
```

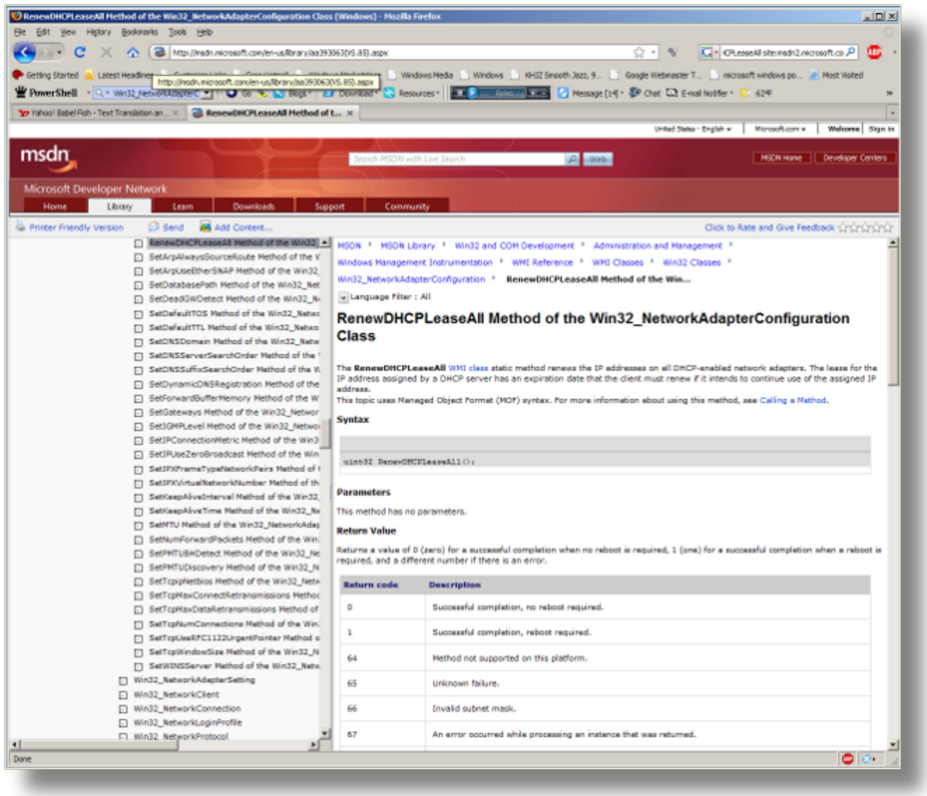
Help with Classes and Methods

The methods of a WMI class are also documented in detail inside WMI. For example, you get the description of the *Win32Shutdown()* method of the *Win32_OperatingSystem* class like this:

```
$class = [wmiclass]'Win32_OperatingSystem'
$class.psbase.Options.UseAmendedQualifiers = $true
(($class.psbase.methods["Win32Shutdown"]).Qualifiers["Description"]).Value

  The Win32Shutdown method provides the full set of shutdown
  options supported by Win32 operating systems. The method returns
  an integer value that can be interpretted as follows:
  0 - Successful completion.
  Other - For integer values other than those listed above, refer
  to Win32 error code documentation.
```

Moreover, nearly all WMI classes have excellent documentation on the Internet. That's a good thing, too, because it's not easy to find out what the method wants from you, especially when WMI methods require arguments.

If you'd like to learn more about a WMI class or a method, navigate to an Internet search page like Google and specify as keyword the WMI class name, as well as the method. It's best to limit your search to the Microsoft MSDN pages: *Win32_NetworkAdapterConfiguration RenewDHCPLeaseAll site:msdn2.microsoft.com.*



MSDN › MSDN Library › Win32 and COM Development › Administration and Management › Windows Management Instrumentation › WMI Reference › WMI Classes › Win32 Classes › Win32_NetworkAdapterConfiguration › RenewDHCPLeaseAll Method of the Win...

RenewDHCPLeaseAll Method of the Win32_NetworkAdapterConfiguration Class

The **RenewDHCPLeaseAll** WMI class static method renews the IP addresses on all DHCP-enabled network adapters. The lease for the IP address assigned by a DHCP server has an expiration date that the client must renew if it intends to continue use of the assigned IP address.
This topic uses Managed Object Format (MOF) syntax. For more information about using this method, see Calling a Method.

Syntax

```
uint32 RenewDHCPLeaseAll();
```

Parameters

This method has no parameters.

Return Value

Returns a value of 0 (zero) for a successful completion when no reboot is required, 1 (one) for a successful completion when a reboot is required, and a different number if there is an error.

Return code	Description
0	Successful completion, no reboot required.
1	Successful completion, reboot required.
64	Method not supported on this platform.
65	Unknown failure.
66	Invalid subnet mask.
67	An error occurred while processing an instance that was returned.

Figure 18.1: WMI classes and their methods are documented in detail on the Internet

WMI Events

WMI returns not only information but can also wait for certain events. If the events occur, an action will be started. In the process, WMI can alert you when one of the following things involving a WMI instance happens:

- **__InstanceCreationEvent:** A new instance was added such as a new process was started or a new file created.
- **__InstanceModificationEvent:** The properties of an instance changed. For example, the FreeSpace property of a drive was modified.
- **__InstanceDeletionEvent:** An instance was deleted, such as a program was shut down or a file deleted.
- **__InstanceOperationEvent:** This is triggered in all three cases.

You can use these to set up an alarm signal. For example, if you want to be informed as soon as Notepad is started, type:

```
Select * from __InstanceCreationEvent WITHIN 1
WHERE targetinstance isa 'Win32_Process' AND
targetinstance.name = 'notepad.exe'
```

WITHIN specifies the time interval of the inspection and "WITHIN 1" means that you want to be informed no later than one second after the event occurs. The shorter you set the interval, the more effort involved, which means that WMI will require commensurately more computing power to perform your task. As long as the interval is kept at not less than one second, the computation effort will be scarcely perceptible. Here is an example:

```
$alarm = New-Object Management.EventQuery
$alarm.QueryString = "Select * from __InstanceCreationEvent `
WITHIN 1 WHERE targetinstance isa 'Win32_Process' AND `
targetinstance.name = 'notepad.exe'"
$watch = New-Object Management.ManagementEventWatcher $alarm
#Start Notepad after issuing a wait command:
$result = $watch.WaitForNextEvent()
#Get target instance of Notepad:
$result.targetinstance
#Access the live instance:
$path = $result.targetinstance.__path
$live = [wmi]$path
# Close Notepad using the live instance
$live.terminate()
```

Remote Access and Namespaces

Maybe you have the impression that WMI intersects with some cmdlets. That is in fact correct. Whether you use *Get-WmiObject Win32_Process* or better *Get-Process* to inspect running processes is often just a matter of taste. Even *Get-WmiObject Win32_Service* and *Get-Service* can return similar results—at least, at first glance.

WMI objects come from an entirely different source than the results of cmdlets, which is why they contain different, often additional information. Moreover, there are innumerable WMI classes for which cmdlets do not exist, because WMI is extensible and many third-party vendors create WMI extensions in additional namespaces. Finally, WMI works locally as well as remotely while most PowerShell cmdlets work only locally.

Accessing WMI Objects on another Computer

Using WMI makes remote access very easy and convenient provided that you have a network connection to the target system, sufficient permissions on that system, and no firewall is operating between you and the target system. Use the *-ComputerName* parameter of *Get-WmiObject* to access another computer system using WMI. Then specify the name of the computer after it:

```
Get-WmiObject -computername pc023 Win32_Process
```

If you want to log on to the target system using another user account, use the *-Credential* parameter to specify additional log on data as in this example:

```
$credential = Get-Credential
Get-WmiObject -computername pc023 -credential $credential Win32_Process
```

Namespaces: WMI Extensions

WMI has a hierarchical structure much like a file system does. Up to now, all the classes that you have used have come from the WMI "directory" root\cimv2. Third-party vendors can create additional WMI directories, known as *Namespaces*, and put in them their own classes, which you can use to control software, like Microsoft Office or hardware like switches and other equipment.

Because the topmost directory in WMI is always named *root*, from its location you can inspect existing namespaces. Get a display first of the namespaces on this level:

```
Get-WmiObject -Namespace root __Namespace | Format-Wide Name

  subscription        DEFAULT
  MicrosoftDfs        CIMV2
  Cli                 nap
  SECURITY            RSOP
  Infineon            WMI
  directory           Policy
  ServiceModel        SecurityCenter
  MSAPPS12            Microsoft
  aspnet
```

As you can see, the *cimv2* directory is only one of them. What other directories are shown here depends on the software and hardware that you use. For example, if you use Microsoft Office, you may find a directory called *MSAPPS12*. Take a look at the classes in it:

```
Get-WmiObject -Namespace root\msapps12 -list |
Where-Object { $_.Name.StartsWith("Win32_") }

  Win32_PowerPoint12Tables               Win32_Publisher12PageNumber
  Win32_Publisher12Hyperlink             Win32_PowerPointSummary
  Win32_Word12Fonts                      Win32_PowerPointActivePresent...
  Win32_OutlookDefaultFileLocation       Win32_Word12Document
  Win32_ExcelAddIns                      Win32_PowerPoint12Table
  Win32_ADOCoreComponents                Win32_Publisher12SelectedTable
  Win32_Word12CharacterStyle             Win32_Word12Styles
  Win32_OutlookSummary                   Win32_Word12DefaultFileLocation
  Win32_WordComAddins                    Win32_PowerPoint12AlternateSt...
  Win32_OutlookComAddins                 Win32_ExcelCharts
  Win32_Word12Settings                   Win32_FrontPageActiveWeb
  Win32_OdbcDriver                       Win32_AccessProject
  Win32_Word12StartupFileLocation        Win32_ExcelActiveWorkbook
  Win32_FrontPagePageProperty            Win32_Publisher12MailMerge
  Win32_Language                         Win32_FrontPageAddIns
  Win32_Word12PageSetup                  Win32_Word12HeaderAndFooter
  Win32_ServerExtension                  Win32_Publisher12ActiveDocume...
  Win32_Word12Addin                      Win32_WordComAddin
  Win32_PowerPoint12PageNumber           Win32_JetCoreComponents
  Win32_Publisher12Fonts                 Win32_Word12Table
  Win32_OutlookAlternateStartupFile      Win32_Word12Tables
  Win32_Access12ComAddins                Win32_Excel12AlternateStartup...
  Win32_Word12FileConverters             Win32_Access12StartupFolder
```

```
    Win32_Word12ParagraphStyle             Win32_Access12ComAddin
    Win32_Excel12StartupFolder             Win32_PowerPointPresentation
    Win32_FrontPageWebProperty             Win32_Publisher12Table
    Win32_Publisher12StartupFolder         Win32_WebConnectionErrorText
    Win32_ExcelSheet                       Win32_Publisher12Tables
    Win32_FrontPageTheme                   Win32_PowerPoint12ComAddins
    Win32_Word12Template                   Win32_ExcelComAddins
    Win32_Access12AlternateStartupFileLoc  Win32_Word12ActiveDocument
    Win32_PublisherSummary                 Win32_Publisher12DefaultFileL...
    Win32_Word12Field                      Win32_Publisher12Hyperlinks
    Win32_PowerPoint12ComAddin             Win32_PowerPoint12Hyperlink
    Win32_PowerPoint12DefaultFileLoc       Win32_Publisher12Sections
    Win32_OutlookStartupFolder             Win32_Access12JetComponents
    Win32_Word12ActiveDocumentNotable      Win32_Publisher12CharacterStyle
    Win32_Word12Hyperlinks                 Win32_Word12MailMerge
    Win32_Word12FileConverter              Win32_PowerPoint12Hyperlinks
    Win32_FrontPageActivePage              Win32_Word12Summary
    Win32_OleDbProvider                    Win32_Publisher12PageSetup
    Win32_Word12SelectedTable              Win32_PowerPoint12StartupFolder
    Win32_OdbcCoreComponent                Win32_PowerPoint12PageSetup
    Win32_FrontPageSummary                 Win32_AccessSummary
    Win32_Word12Hyperlink                  Win32_OfficeWatsonLog
    Win32_Publisher12Font                  Win32_WebConnectionErrorMessage
    Win32_AccessDatabase                   Win32_Publisher12Styles
    Win32_Publisher12ActiveDocument        Win32_Word12AlternateStartupF...
    Win32_PowerPoint12Fonts                Win32_Word12Sections
    Win32_ExcelComAddin                    Win32_Excel12DefaultFileLoc
    Win32_Word12Fields                     Win32_ExcelActiveWorkbookNotable
    Win32_Publisher12COMAddIn              Win32_ExcelWorkbook
    Win32_OutlookComAddin                  Win32_PowerPoint12Font
    Win32_FrontPageAddIn                   Win32_ExcelChart
    Win32_WebConnectionError               Win32_Word12Font
    Win32_RDOCoreComponents                Win32_Word12PageNumber
    Win32_Publisher12ParagraphStyle        Win32_Publisher12COMAddIns
    Win32_Transport                        Win32_Access12DefaultFileLoc
    Win32_FrontPageThemes                  Win32_ExcelSummary
    Win32_ExcelAddIn                       Win32_Publisher12AlternateSta...
    Win32_PowerPoint12SelectedTable
```

WMI and the Extended Type System

In Chapters 5 and 6, you learned a few things about the PowerShell *Extended Type System*. With its help, you can give objects new properties and methods. That is very useful in the case of WMI. The Extended Type System can do more: it can be used to add on type converters. You'll see later why that's useful.

Converting the WMI Date Format

WMI includes some untypical date formats. Particularly, the date and time format looks very weird. For example, look at the example of the *Win32_OperatingSystem* class:

```
Get-WmiObject win32_Operatingsystem | Format-List *time*

  CurrentTimeZone : 120
  LastBootUpTime  : 20071016085609.375199+120
  LocalDateTime   : 20071016153922.498000+120
```

The date and time are given as a sequence of numbers, first the year, then the month, and finally the day. Following this is the time in hours, minutes, and milliseconds, and then the time zone. This is the so-called *DMTF*, which is hard to read. However, you can use *ToDateTime()* of the *ManagementDateTimeConverter*.NET class to decipher this cryptic format:

```
$boottime = (Get-WmiObject win32_Operatingsystem).LastBootUpTime
$boottime

  20071016085609.375199+120

$realtime = [System.Management.ManagementDateTimeConverter]::`
ToDateTime($boottime)
$realtime

  Tuesday, October 16, 2007 8:56:09 AM
```

You only need to take one look to see what the date and the time are now. Moreover, you can also continue to work with the time indicator in various ways, such as using *New-TimeSpan* to calculate current system uptime:

```
New-TimeSpan $realtime (get-date)

  Days              : 0
  Hours             : 6
  Minutes           : 47
  Seconds           : 9
  Milliseconds      : 762
  Ticks             : 244297628189
  TotalDays         : 0.282751884478009
  TotalHours        : 6.78604522747222
  TotalMinutes      : 407.162713648333
  TotalSeconds      : 24429.7628189
  TotalMilliseconds : 24429762.8189
```

Adding On a Type Converter

It would be much more logical if you could convert the WMI date format by type conversion into a *DateTime* format, such as like this:

```
[datetime]"20071016085609.375199+120"

  Cannot convert value "20071016085609.375199+120" to
  type "System.DateTime". Error: "String was not recognized
  as a valid DateTime."
  At line:1 char:11
  + [datetime]" <<<< 20071016085609.375199+120"
```

This fails because the standard type converter is not the right tool for this conversion. But the Extended Type System can add on not only properties and methods, but also type converters. To see how, make a type converter first:

```
notepad typeconverter.cs
```

Notepad offers to create a new file. Agree, and then type this code:

```
using System.Management.Automation;
using System;
using System.IO;
using System.Management;
namespace WMItoDate
{
 public class DateTimeTypeConverter : PSTypeConverter
 {
  public override bool CanConvertFrom(Object sourceValue, Type destinationType)
  {
   string src = sourceValue as string;
   if (src != null)
   {
    try
    {
     DateTime Date = ManagementDateTimeConverter.ToDateTime(src);
     if (Date != null) return true;
    }
    catch (Exception)
    {
     return false;
    }
   }
   return false;
  }
  public override object ConvertFrom(object sourceValue, Type destinationType,
    IFormatProvider provider, bool IgnoreCase)
  {
   if (sourceValue == null) throw new InvalidCastException("Conversion error");
   if (this.CanConvertFrom(sourceValue, destinationType))
   {
    try
    {
     string src = sourceValue as string;
     DateTime Date = ManagementDateTimeConverter.ToDateTime(src);
     return Date;
```

```
      }
      catch (Exception)
      {
       throw new InvalidCastException("Conversion error");
      }
     }
     throw new InvalidCastException("Conversion error");
    }
    public override bool CanConvertTo(object Value, Type destinationType)
    {
     return false;
    }
    public override object ConvertTo(object Value, Type destinationType,
      IFormatProvider provider, bool IgnoreCase)
    {
     throw new InvalidCastException("Conversion error");
    }
   }
  }
```

Save the code as the code has to be compiled in a DLL library. PowerShell can take care of this chore for you:

```
$compiler = "$env:windir/Microsoft.NET/Framework/v2.0.50727/csc"
$ref = [PsObject].Assembly.Location
&$compiler /target:library /reference:$ref typeconverter.cs
```

The result is the file *typeconverter.dll*. Now all you have to do is load it in PowerShell:

```
$path = resolve-path .\typeconverter.dll
[void][System.Reflection.Assembly]::LoadFrom($path)
```

The Extended Type System must be informed that a new type converter is available. To do so, create a *ps1xml* file that basically contains XML data:

```
notepad typeconverter.wmi.ps1xml
```

Agree to creation of the file, and type this code:

```
    <Types>
     <Type>
      <Name>System.DateTime</Name>
      <TypeConverter>
       <TypeName>WMItoDate.DateTimeTypeConverter</TypeName>
      </TypeConverter>
     </Type>
    </Types>
```

Save the file and import the extension into the *Extended Type System*:

```
Update-TypeData typeconverter.wmi.ps1xml
```

Finally, try out the extension. From now on, PowerShell can use type conversion to convert WMI dates into *DateTime* specifications:

```
[datetime]"20071016085609.375199+120"

  Tuesday, October 16, 2007 8:56:09 AM
```

tip So that the extension automatically remains in operation, you have to load your DLL library into one of your PowerShell start profiles. You also have to load the type extension into the profile using *Update-TypeData*.

CHAPTER 19.

User Management

For many administrators, managing users is an important part of their work. PowerShell V1 does not contain any cmdlets to manage users. However, you can add them from third-party vendors. But if you do not want any dependencies on third-party tools and snap-ins, you will learn in this chapter how to use native .NET framework methods for user management.

Topics Covered:

Connecting to a Domain

If your computer is a member of a domain, the first step in managing users is to connect to a logon domain. You can set up a connection like this:

```
$domain = [ADSI]""
$domain

  distinguishedName
  -----------------
  {DC=scriptinternals,DC=technet}
```

If your computer isn't a member of a domain, the connection setup will fail and generate an error message:

```
  out-lineoutput : Exception retrieving member
  "ClassId2e4f51ef21dd47e99d3c952918aff9cd": "The specified
  domain either does not exist or could not be contacted."
```

If you want to manage local user accounts and groups, instead of LDAP: use the *WinNT:* moniker. But watch out: case-sensitivity is in effect. For example, you can access the local administrator account like this:

```
$user = [ADSI]"WinNT://./Administrator,user"
$user | Format-List *
```

We won't go into local user accounts in any more detail in the following examples.

Logging On Under Other User Names

Behind the name *[ADSI]* is a PowerShell type accelerator. *[ADSI]* actually corresponds to the *DirectoryServices.DirectoryEntry* .NET type. That's why you could have set up the previous connection this way as well:

```
$domain = [DirectoryServices.DirectoryEntry]""
$domain

  distinguishedName
  -----------------
  {DC=scriptinternals,DC=technet}
```

This is important to know if you don't want to log on with your current user account but with another account. The *[ADSI]* type accelerator always logs you on using your current identity. By comparison, the underlying *DirectoryServices.DirectoryEntry* .NET type gives you the option of logging on with another identity. But why would anyone want to do something like that? Here are a few reasons:

- **External consultant:** You may be visiting a company as an external consultant and have brought along your own notebook computer, which isn't a member of the company domain. This prevents you from setting up a connection to the company domain. But if you have a valid user account along with its password at your disposal, you can use your notebook and this identity to access the company domain. Your notebook doesn't have to be a domain member to access the domain.

- **Several domains:** Your company has several domains and you want to manage one of them, but it isn't your logon domain. More likely than not, you'll have to log on to the new domain with an identity known to it.

Logging onto a domain that isn't your own with another identity works like this:

```
$domain = New-Object DirectoryServices.DirectoryEntry(
"LDAP://10.10.10.1","domain\user", "secret")
$domain.name

  scriptinternals

$domain.distinguishedName

  DC=scriptinternals,DC=technet
```

note

Two things are important for ADSI paths. First, their names are case-sensitive. That's why the two following approaches are wrong:

```
        $domain = [ADSI]"ldap://10.10.10.1"                #
Wrong!
$useraccount = [ADSI]"Winnt://./Administrator,user"    # Wrong!
```

Second, surprisingly enough, ADSI paths use a normal slash. A backslash like the one commonly used in the file system would generate error messages:

```
$domain = [ADSI]"LDAP:\\10.10.10.1"                    # Wrong!
$useraccount = [ADSI]"WinNT:\\.\Administrator,user"    # Wrong!
```

If you don't want to put logon data in plain text in your code, use *Get-Credential*. Since the password has to be given when logging on in plain text, and *Get-Credential* returns the password in encrypted form, an intermediate step is required in which it is converted into plain text:

```
$cred = Get-Credential
$pwd = [Runtime.InteropServices.Marshal]::PtrToStringAuto(
  [Runtime.InteropServices.Marshal]::SecureStringToBSTR($cred.Password))
$domain = New-Object DirectoryServices.DirectoryEntry(
  "LDAP://10.10.10.1",$cred.UserName, $pwd)
$domain.name

  scriptinternals
```

tip Logon errors are initially invisible. PowerShell reports errors only when you try to connect with a domain. This procedure is known as "binding." Calling the *$domain.Name* property won't cause any errors because when the connection fails, there isn't even any property called *Name* in the object in *$domain*.

So, how can you find out whether a connection was successful or not? Just invoke the *Bind()* method, which does the binding. *Bind()* always throws an exception and *Trap* can capture this error.

The code called by *Bind()* must be in its own scriptblock, which means it must be enclosed in braces. If an error occurs in the block, PowerShell will cut off the block and execute the *Trap* code, where the error will be stored in a variable. This is created using *script:* so that the rest of the script can use the variable. Then *If* verifies whether an error occurred. A connection error always exists if the exception thrown by *Bind()* has the *-2147352570*error code. In this event, *If* outputs the text of the error message and stops further instructions from running by using *Break*.

```
$cred = Get-Credential
$pwd = [Runtime.InteropServices.Marshal]::PtrToStringAuto(
  [Runtime.InteropServices.Marshal]::SecureStringToBSTR($cred.Password
))
$domain = New-Object DirectoryServices.DirectoryEntry(
  "LDAP://10.10.10.1",$cred.UserName, $pwd)
trap { $script:err = $_ ; continue } &{
  $domain.Bind($true); $script:err = $null }
if ($err.Exception.ErrorCode -ne -2147352570)
{
  Write-Host -Fore Red $err.Exception.Message
  break
}
else
{
  Write-Host -Fore Green "Connection established."
}

  Logon failure: unknown user name or bad password.
```

By the way, the error code *-2147352570* means that although the connection was established, *Bind()* didn't find an object to which it could bind itself. That's OK because you didn't specify any particular object in your LDAP path when the connection was being set up..

Accessing a Container

Domains have a hierarchical structure like the file system directory structure. Containers inside the domain are either predefined directories or subsequently created organizational units. If you want to access a container, specify the LDAP path to the container. For example, if you want to access the predefined directory *Users*, you could access like this:

```
$ldap = "/CN=Users,DC=scriptinternals,DC=technet"
$cred = Get-Credential
$pwd = [Runtime.InteropServices.Marshal]::PtrToStringAuto(
  [Runtime.InteropServices.Marshal]::SecureStringToBSTR($cred.Password))
$users = New-Object DirectoryServices.DirectoryEntry(
  "LDAP://10.10.10.1$ldap",$cred.UserName, $pwd)
$users

  distinguishedName
  -----------------
  {CN=Users,DC=scriptinternals,DC=technet}
```

The fact that you are logged on as a domain member naturally simplifies the procedure considerably because now you need neither the IP address of the domain controller nor logon data. The LDAP name of the domain is also returned to you by the domain itself in the *distinguishedName* property. All you have to do is specify the container that you want to visit:

```
$ldap = "CN=Users"
$domain = [ADSI]""
$dn = $domain.distinguishedName
$users = [ADSI]"LDAP://$ldap,$dn"
$users
```

While in the LDAP language predefined containers use names including *CN=*, specify *OU=* for organizational units. So, when you log on as a user to connect to the *sales* OU, which is located in the *company* OU, you should type:

```
$ldap = "OU=sales,OU=company"
$domain = [ADSI]""
$dn = $domain.distinguishedName
$users = [ADSI]"LDAP://$ldap,$dn"
$users
```

Listing Container Contents

At some point, you'd like to know who or what the container contains to which you have set up a connection. The approach here is somewhat less intuitive because now you need the *PSBase* object. PowerShell wraps Active Directory objects and adds new properties and methods while removing others. Unfortunately, PowerShell also in the process gets rid of the necessary means to get to the contents of a container. *PSBase* returns the original (raw) object just like PowerShell received it before conversion, and this object knows the *Children* property:

```
$ldap = "CN=Users"
```

```
$domain = [ADSI]""
$dn = $domain.distinguishedName
$users = [ADSI]"LDAP://$ldap,$dn"
$users.PSBase.Children

  distinguishedName
  -----------------
  {CN=admin,CN=Users,DC=scriptinternals,DC=technet}
  {CN=Administrator,CN=Users,DC=scriptinternals,DC=technet}
  {CN=All,CN=Users,DC=scriptinternals,DC=technet}
  {CN=ASPNET,CN=Users,DC=scriptinternals,DC=technet}
  {CN=Belle,CN=Users,DC=scriptinternals,DC=technet}
  {CN=Consultation2,CN=Users,DC=scriptinternals,DC=technet}
  {CN=Consultation3,CN=Users,DC=scriptinternals,DC=technet}
  {CN=ceimler,CN=Users,DC=scriptinternals,DC=technet}
  (...)
```

Accessing Individual Users or Groups

There are various ways to access individual users or groups. For example, you can filter the contents of a container. You can also specifically select individual items from a container or access them directly through their LDAP path. And you can search for items across directories.

Using Filters and the Pipeline

Children gets back fully structured objects that, as shown in Chapter 5, you can process further in the PowerShell pipeline. Among other things, if you want to list only users, not groups, you could query the *sAMAccountType* property and use it as a filter criterion:

```
$ldap = "CN=Users"
$domain = [ADSI]""
$dn = $domain.distinguishedName
$users = [ADSI]"LDAP://$ldap,$dn"
$users.PSBase.Children |
  Where-Object { $_.sAMAccountType -eq 805306368 }
```

Another approach makes use of the class that you can always find in the *objectClass* property.

```
$users.PSBase.Children |
  Select-Object -first 1 |
  ForEach-Object { $_.sAMAccountName + $_.objectClass }

  admin
  top
  person
  organizationalPerson
  user
```

As it happens, the *objectClass* property contains an array with all the classes from which the object is derived. The listing process proceeds from the general to the specific so you can find only those elements that are derived from the *user* class:

```
$users.PSBase.Children |
  Where-Object { $_.objectClass -contains "user" }

  distinguishedName
  -----------------
  {CN=admin,CN=Users,DC=scriptinternals,DC=technet}
  {CN=Administrator,CN=Users,DC=scriptinternals,DC=technet}
  {CN=ASPNET,CN=Users,DC=scriptinternals,DC=technet}
  {CN=Belle,CN=Users,DC=scriptinternals,DC=technet}
  (...)
```

Directly Accessing Elements

If you know the ADSI path to a particular object, you don't have to resort to a circuitous approach but can access it directly through the pipeline filter. You can find the path of an object in the *distinguishedName* property:

```
$users.PSBase.Children |
  Format-Table sAMAccountName, distinguishedName -wrap

  sAMAccountName     distinguishedName
  --------------     -----------------
  {admin}            {CN=admin,CN=Users,DC=scriptinternals,
                     DC=technet}
  {Administrator}    {CN=Administrator,CN=Users,DC=scriptin
                     ternals,DC=technet}
  {All}              {CN=All,CN=Users,DC=scriptinternals,DC
                     =technet}
  {ASPNET}           {CN=ASPNET,CN=Users,DC=scriptinternals
                     ,DC=technet}
  {Belle}            {CN=Belle,CN=Users,DC=scriptinternals,
                     DC=technet}
  {consultation2}    {CN=consultation2,CN=Users,DC=scriptin
                     ternals,DC=technet}
  {consultation3}    {CN=consultation3,CN=Users,DC=scriptin
                     ternals,DC=technet}
  (...)
```

For example, if you want to access the *Guest* account directly, specify its *distinguishedName*. If you're a domain member, you don't have to go to the trouble of using the *distinguishedName* of the domain:

```
$ldap = "CN=Guest,CN=Users"
$domain = [ADSI]""
$dn = $domain.distinguishedName
$guest = [ADSI]"LDAP://$ldap,$dn"
$guest | Format-List *
```

```
objectClass            : {top, person, organizationalPerson, user}
cn                     : {Guest}
description            : {Predefined account for guest access to the
                         computer or domain}
distinguishedName      : {CN=Guest,CN=Users,DC=scriptinternals,DC=
                         technet}
instanceType           : {4}
whenCreated            : {12.11.2005 12:31:31 PM}
whenChanged            : {06.27.2006 09:59:59 AM}
uSNCreated             : {System.__ComObject}
memberOf               : {CN=Guests,CN=Builtin,DC=scriptinternals,DC=
                         technet}
uSNChanged             : {System.__ComObject}
name                   : {Guest}
objectGUID             : {240 255 168 180 1 206 85 73 179 24 192 164
                         100 28 221 74}
userAccountControl     : {66080}
badPwdCount            : {0}
codePage               : {0}
countryCode            : {0}
badPasswordTime        : {System.__ComObject}
lastLogoff             : {System.__ComObject}
lastLogon              : {System.__ComObject}
logonHours             : {255 255 255 255 255 255 255 255 255 255 255
                         255 255 255 255 255 255 255 255 255 255}
pwdLastSet             : {System.__ComObject}
primaryGroupID         : {514}
objectSid              : {1 5 0 0 0 0 0 5 21 0 0 0 184 88 34 189 250
                         183 7 172 165 75 78 29 245 1 0 0}
accountExpires         : {System.__ComObject}
logonCount             : {0}
sAMAccountName         : {Guest}
sAMAccountType         : {805306368}
objectCategory         : {CN=Person,CN=Schema,CN=Configuration,DC=
                         scriptinternals,DC=technet}
isCriticalSystemObject : {True}
nTSecurityDescriptor   : {System.__ComObject}
```

Using the asterisk as wildcard character, *Format-List*makes all the properties of an ADSI object visible so that you can easily see which information is contained in it and under which names.

Obtaining Elements from a Container

You already know what to use to read out all the elements in a container: *PSBase.Children*. However, by using *PSBase.Find()* you can also retrieve individual elements from a container:

```
$domain = [ADSI]""
$users = $domain.psbase.Children.Find("CN=Users")
$useraccount = $users.psbase.Children.Find("CN=Administrator")
$useraccount.Description
```

```
    Predefined account for managing the computer or domain.
```

Searching for Elements

You've had to know exactly where in the hierarchy of domain a particular element is stored to access it. In larger domains, it can be really difficult to relocate a particular user account or group. That's why a domain can be accessed and searched like a database.

Once you have logged on to a domain that you want to search, you need only the following few lines to find all of the user accounts that match the user name in *$UserName*. Wildcard characters are allowed:

```
$UserName = "*mini*"
$searcher = New-Object DirectoryServices.DirectorySearcher([ADSI]"")
$searcher.filter = "(&(objectClass=user)(sAMAccountName= $UserName))"
$searcher.findall()
```

If you haven't logged onto the domain that you want to search, get the domain object through the logon:

```
$domain = New-Object DirectoryServices.DirectoryEntry(
  "LDAP://10.10.10.1","domain\user", "secret")
$UserName = "*mini*"
$searcher = New-Object DirectoryServices.DirectorySearcher($domain)
$searcher.filter = "(&(objectClass=user)(sAMAccountName= $UserName))"
$searcher.findall() | Format-Table -wrap
```

The results of the search are all the objects that contain the string "mini" in their names, no matter where they're located in the domain:

```
    Path                                  Properties
    ----                                  ----------
    LDAP://10.10.10.1/CN=Administrator,   {samaccounttype, lastlogon,
    CN=Users,DC=scriptinternals,          objectsid, whencreated...}
    DC=technet
```

The crucial part takes place in the search filter, which looks a bit strange in this example:

```
$searcher.filter = "(&(objectClass=user)(sAMAccountName= $UserName))"
```

The filter merely compares certain properties of elements according to certain requirements. It checks accordingly whether the term *user* turns up in the *objectClass* property and whether the *sAMAccountName* property matches the specified user name. Both criteria are combined by the "&" character, so they both have to be met. This would enable you to assemble a convenient search function.

note

The search function *Get-LDAPUser* searches the current logon domain by default. If you want to log on to another domain, note the appropriate lines in the function and specify your logon data.

```
function Get-LDAPUser([string]$UserName, [string]$Start)
{
  # Use current logon domain:
  $domain = [ADSI]""
  # OR: log on to another domain:
  #   $domain = New-Object DirectoryServices.DirectoryEntry(
  #   "LDAP://10.10.10.1","domain\user", "secret")
  If ($start -ne "")
  {
    $startelement = $domain.psbase.Children.Find($start)
  }
  else
  {
    $startelement = $domain
  }
  $searcher = New-Object DirectoryServices.DirectorySearcher($startelement)
  $searcher.filter = "(&(objectClass=user)(sAMAccountName=$UserName))"
  $Searcher.CacheResults = $true
  $Searcher.SearchScope = "Subtree"
  $Searcher.PageSize = 1000
  $searcher.findall()
}
```

Get-LDAPUser can be used very flexibly and locates user accounts everywhere inside the domain. Just specify the name you're looking for or a part of it:

```
# Find all users who have an "e" in their names:
Get-LDAPUser *e*
# Find only users with "e" in their names that are
# in the "main office" OU or come under it.
Get-LDAPUser *e* "OU=main office,OU=company"
```

Get-LDAPUser gets the found user objects right back. You can subsequently process them in the PowerShell pipeline—just like the elements that you previously got directly from children. How does *Get-LDAPUser* manage to search only the part of the domain you want it to? The following snippet of code is the reason:

```
If ($start -ne "")
{
  $startelement = $domain.psbase.Children.Find($start)
}
else
{
  $startelement = $domain
}
```

First, we checked whether the user specified the *$start* second parameter. If yes, *Find()* is used to access the specified container in the domain container (of the topmost level) and this is defined as the starting point for the search. If *$start* is missing, the starting point is the topmost level of the domain, meaning that every location is searched.

pro tip

The function also specifies some options that are defined by the user:

```
        $Searcher.CacheResults = $true
$Searcher.SearchScope = "Subtree"
$Searcher.PageSize = 1000
```

SearchScope determines whether all child directories should also be searched recursively beginning from the starting point, or whether the search should be limited to the start directory. *PageSize* specifies in which "chunk" the results of the domain are to be retrieved. If you reduce the *PageSize*, your script may respond more freely, but will also require more network traffic. If you request more, the respective "chunk" will still include only 1,000 data records.

You could now freely extend the example function by extending or modifying the search filter. Here are some useful examples:

Search Filter	**Description**
`(&(objectCategory=person)(objectClass=User))`	Find only user accounts, not computer accounts
`(sAMAccountType=805306368)`	Find only user accounts (much quicker, but harder to read)
`(&amp;(objectClass=user)(sn=Weltner)(givenName=Tobias))`	Find user accounts with a particular name
`(&(objectCategory=person)(objectClass=user)(msNPAllowDialin=TRUE))`	Find user with dial-in permission
`(&(objectCategory=person)(objectClass=user)(pwdLastSet=0))`	Find user who has to change password

	at next logon
(&(objectCategory=computer)(!description=*))	Find all computer accounts having no description
(&(objectCategory=person)(description=*))	Find all user accounts having no description
(&(objectCategory=person)(objectClass=user)(whenCreated>=20050318000000.0Z))	Find all elements created after March 18, 2005
(&(objectCategory=person)(objectClass=user)(|(accountExpires=9223372036854775807)(accountExpires=0)))	Find all users whose account never expires (OR condition, where only one condition must be met)
(&(objectClass=user)(userAccountControl:1.2.840.113556.1.4.803:=2))	Find all disabled user accounts (bitmask logical AND)
(&(objectCategory=person)(objectClass=user)(userAccountControl:1.2.840.113556.1.4.803:=32))	Find all users whose password never expires
(&(objectClass=user)(!userAccountControl:1.2.840.113556.1.4.803:=65536))	Find all users whose password expires (logical NOT using "!")
(&(objectCategory=group)(!groupType:1.2.840.113556.1.4.803:=2147483648))	Finding all distribution groups
(&(objectCategory=Computer)(!userAccountControl:1.2.840.113556.1.4.803:=8192))	Finding all computer accounts that are not domain controllers

Table 19.1: Examples of LDAP queries

Accessing Elements Using GUID

Elements in a domain are subject to change. The only thing that is really constant is the so-called GUID of an account. A GUID is assigned just one single time, namely when the object is created, after which it always remains the same. You can find out the GUID of an element by accessing the account. For example, use the practical *Get-LDAPUser* function above:

```
$searchuser = Get-LDAPUser "Guest"
$useraccount = $searchuser.GetDirectoryEntry()
$useraccount.psbase.NativeGUID

  f0ffa8b401ce5549b318c0a4641cdd4a
```

Because the results returned by the search include no "genuine" user objects, but only reduced *SearchResult* objects, you must first use *GetDirectoryEntry()* to get the real user object. This step is only necessary if you want to process search results. You can find the GUID of an account in *PSBase.NativeGUID*.

In the future, you can access precisely this account via its GUID. Then you won't have to care whether the location, the name, or some other property of the user accounts changes. The GUID will always remain constant:

```
$acccount = [ADSI]"LDAP://<GUID=f0ffa8b401ce5549b318c0a4641cdd4a>"
$acccount

  distinguishedName
  -----------------
  {CN=Guest,CN=Users,DC=scriptinternals,DC=technet}
```

Specify the GUID when you log on if you want to log on to the domain:

```
$guid = "<GUID=f0ffa8b401ce5549b318c0a4641cdd4a>"
$acccount = New-Object DirectoryServices.DirectoryEntry(
  "LDAP://10.10.10.1/$guid","domain\user", "secret")

  distinguishedName
  -----------------
  {CN=Guest,CN=Users,DC=scriptinternals,DC=technet}
```

Reading and Modifying Properties

In the last section, you learned how to access individual elements inside a domain: either directly through the ADSI path, the GUID, searching through directory contents, or launching a search across domains.

The elements you get this way are full-fledged objects. You use the methods and properties of these elements to control them. Basically, everything applies that you read about in Chapter 6. In the case of ADSI, there are some additional special features:

- **Twin objects:** Every ADSI object actually exists twice: first, as an object PowerShell synthesizes and then as a raw ADSI object. You can access the underlying raw object via the *PSBase* property of the processed object. The processed object contains all Active Directory attributes, including possible schema extensions. The underlying base object contains the .NET properties and methods you need for general management. You already saw how to access these two objects when you used *Children* to list the contents of a container.
- **Phantom objects:** Search results of a cross-domain search look like original objects only at first sight. In reality, these are reduced *SearchResult* objects. You can get the real ADSI object by using the *GetDirectoryEntry()* method. You just saw how that happens in the section on GUIDs.
- **Properties:** All the changes you made to ADSI properties won't come into effect until you invoke the *SetInfo()* method.

note In the following examples, we will use the *Get-LDAPUser* function described above to access user accounts, but you can also get at user accounts with one of the other described approaches.

Just What Properties Are There?

There are theoretical and a practical approaches to establishing which properties any ADSI object contains.

Practical Approach: Look

The practical approach is the simplest one: if you output the object to the console, PowerShell will convert all the properties it contains into text so that you not only see the properties, but also right away which values are assigned to the properties. In the following example, the user object is the result of an ADSI search, to be precise, of the above-mentioned *Get-LDAPUser* function:

```
$useraccount = Get-LDAPUser Guest
$useraccount | Format-List *

  Path       : LDAP://10.10.10.1/CN=Guest,CN=Users,
               DC=scriptinternals,DC=technet
  Properties : {samaccounttype, lastlogon, objectsid,
               whencreated...}
```

The result is meager but, as you know by now, search queries only return a reduced *SearchResult* object. You get the real user object from it by calling *GetDirectoryEntry()*. Then you'll get more information:

```
$useraccount = $useraccount.GetDirectoryEntry()
```

```
$useraccount | Format-List *

  objectClass             : {top, person, organizationalPerson, user}
  cn                      : {Guest}
  description             : {Predefined account for guest access to
                            the computer or domain)
  distinguishedName       : {CN=Guest,CN=Users,DC=scriptinternals,
                            DC=technet}
  instanceType            : {4}
  whenCreated             : {12.12.2005 12:31:31 PM}
  whenChanged             : {06.27.2006 09:59:59 AM}
  uSNCreated              : {System.__ComObject}
  memberOf                : {CN=Guests,CN=Builtin,DC=scriptinternals,
                            DC=technet}
  uSNChanged              : {System.__ComObject}
  name                    : {Guest}
  objectGUID              : {240 255 168 180 1 206 85 73 179 24 192
                            164 100 28 221 74}
  userAccountControl      : {66080}
  badPwdCount             : {0}
  codePage                : {0}
  countryCode             : {0}
  badPasswordTime         : {System.__ComObject}
  lastLogoff              : {System.__ComObject}
  lastLogon               : {System.__ComObject}
  logonHours              : {255 255 255 255 255 255 255 255 255 255 255
                            255 255 255 255 255 255 255 255 255 255}
  pwdLastSet              : {System.__ComObject}
  primaryGroupID          : {514}
  objectSid               : {1 5 0 0 0 0 0 5 21 0 0 0 184 88 34 189 250
                            183 7 172 165 75 78 29 245 1 0 0}
  accountExpires          : {System.__ComObject}
  logonCount              : {0}
  sAMAccountName          : {Guest}
  sAMAccountType          : {805306368}
  objectCategory          : {CN=Person,CN=Schema,CN=Configuration,
                            DC=scriptinternals,DC=technet}
  isCriticalSystemObject : {True}
  nTSecurityDescriptor    : {System.__ComObject}
```

In addition, further properties are available in the underlying base object:

```
$useraccount.PSBase | Format-List *

  AuthenticationType : Secure
  Children           : {}
  Guid               : b4a8fff0-ce01-4955-b318-c0a4641cdd4a
  ObjectSecurity     : System.DirectoryServices.ActiveDirec
                       torySecurity
  Name               : CN=Guest
  NativeGuid         : f0ffa8b401ce5549b318c0a4641cdd4a
  NativeObject       : {}
```

```
    Parent              : System.DirectoryServices.Directory
                          Entry
    Password            :
    Path                : LDAP://10.10.10.1/CN=Guest,CN=Users,
                          DC=scriptinternals,DC=technet
    Properties          : {objectClass, cn, description, disti
                          nguishedName...}
    SchemaClassName     : user
    SchemaEntry         : System.DirectoryServices.Directory
                          Entry
    UsePropertyCache    : True
    Username            : scriptinternals\Administrator
    Options             : System.DirectoryServices.Directory
                          EntryConfiguration
    Site                :
    Container           :
```

The difference between these two objects: the object that was returned first represents the respective user. The underlying base object is responsible for the ADSI object itself and, for example, reports where it is stored inside a domain or what is its unique GUID. The *UserName* property, among others, does not state whom the user account represents (which in this case is *Guest*), but who called it (*Administrator*).

Theoretical Approach: Much More Thorough

The practical approach we just saw is quick and returns a lot of information, but it is also incomplete. PowerShell shows only those properties in the output that actually do include a value right then (even if it is an empty value). In reality, many more properties are available so the tool you need to list them is *Get-Member*:

```
  $useraccount | Get-Member -memberType *Property

    Name                   MemberType Definition
    ----                   ---------- ----------
    accountExpires         Property   System.DirectoryServices.
                                      PropertyValueCollection
                                      accountExpires {get;set;}
    badPasswordTime        Property   System.DirectoryServices.
                                      PropertyValueCollection
                                      badPasswordTime {get;set;}
    badPwdCount            Property   System.DirectoryServices.
                                      PropertyValueCollection
                                      badPwdCount {get;set;}
    cn                     Property   System.DirectoryServices.
                                      PropertyValueCollection
                                      cn {get;set;}
    codePage               Property   System.DirectoryServices.
                                      PropertyValueCollection
                                      codePage {get;set;}
    countryCode            Property   System.DirectoryServices.
                                      PropertyValueCollection
```

```
                                   countryCode {get;set;}
description            Property   System.DirectoryServices.
                                   PropertyValueCollection
                                   description {get;set;}
distinguishedName      Property   System.DirectoryServices.
                                   PropertyValueCollection
                                   distinguishedName {get;...
instanceType           Property   System.DirectoryServices.
                                   PropertyValueCollection
                                   instanceType {get;set;}
isCriticalSystemObject Property   System.DirectoryServices.
                                   PropertyValueCollection
                                   isCriticalSystemObject ...
lastLogoff             Property   System.DirectoryServices.
                                   PropertyValueCollection
                                   lastLogoff {get;set;}
lastLogon              Property   System.DirectoryServices.
                                   PropertyValueCollection
                                   lastLogon {get;set;}
logonCount             Property   System.DirectoryServices.
                                   PropertyValueCollection
                                   logonCount {get;set;}
logonHours             Property   System.DirectoryServices.
                                   PropertyValueCollection
                                   logonHours {get;set;}
memberOf               Property   System.DirectoryServices.
                                   PropertyValueCollection
                                   memberOf {get;set;}
name                   Property   System.DirectoryServices.
                                   PropertyValueCollection
                                   name {get;set;}
nTSecurityDescriptor   Property   System.DirectoryServices.
                                   PropertyValueCollection
                                   nTSecurityDescriptor {g...
objectCategory         Property   System.DirectoryServices.
                                   PropertyValueCollection
                                   objectCategory {get;set;}
objectClass            Property   System.DirectoryServices.
                                   PropertyValueCollection
                                   objectClass {get;set;}
objectGUID             Property   System.DirectoryServices.
                                   PropertyValueCollection
                                   objectGUID {get;set;}
objectSid              Property   System.DirectoryServices.
                                   PropertyValueCollection
                                   objectSid {get;set;}
primaryGroupID         Property   System.DirectoryServices.
                                   PropertyValueCollection
                                   primaryGroupID {get;set;}
pwdLastSet             Property   System.DirectoryServices.
                                   PropertyValueCollection
                                   pwdLastSet {get;set;}
sAMAccountName         Property   System.DirectoryServices.
```

```
                                PropertyValueCollection
                                sAMAccountName {get;set;}
sAMAccountType         Property   System.DirectoryServices.
                                PropertyValueCollection
                                sAMAccountType {get;set;}
userAccountControl     Property   System.DirectoryServices.
                                PropertyValueCollection
                                userAccountControl {get...
uSNChanged             Property   System.DirectoryServices.
                                PropertyValueCollection
                                uSNChanged {get;set;}
uSNCreated             Property   System.DirectoryServices.
                                PropertyValueCollection
                                uSNCreated {get;set;}
whenChanged            Property   System.DirectoryServices.
                                PropertyValueCollection
                                whenChanged {get;set;}
whenCreated            Property   System.DirectoryServices.
                                PropertyValueCollection
                                whenCreated {get;set;}
```

In this list, you will also learn whether properties are only readable or if they can also be modified. Modifiable properties are designated by *{get;set;}* and read-only by *{get;}*. If you change a property, the modification won't come into effect until you subsequently call *SetInfo()*.

```
$useraccount.Description = "guest account"
$useraccount.SetInfo()
```

Moreover, *Get-Member* can supply information about the underlying *PSBase* object:

```
$useraccount.PSBase | Get-Member -MemberType *Property
```

```
TypeName: System.Management.Automation.PSMemberSet
Name                MemberType Definition
----                ---------- ----------
AuthenticationType Property   System.DirectoryServices.
                              AuthenticationTypes Authe
                              nticationType {get;set;}
Children            Property   System.DirectoryServices.
                              DirectoryEntries Children
                              {get;}
Container           Property   System.ComponentModel.
                              IContainer Container {get;}
Guid                Property   System.Guid Guid {get;}
Name                Property   System.String Name {get;}
NativeGuid          Property   System.String NativeGuid
                              {get;}
NativeObject        Property   System.Object NativeObject
                              {get;}
ObjectSecurity      Property   System.DirectoryServices.
                              ActiveDirectorySecurity
```

```
                                          ObjectSecurity {get;set;}
  Options              Property           System.DirectoryServices.
                                          DirectoryEntryConfiguration
                                          Options {get;}
  Parent               Property           System.DirectoryServices.
                                          DirectoryEntry Parent
                                          {get;}
  Password             Property           System.String Password
                                          {set;}
  Path                 Property           System.String Path
                                          {get;set;}
  Properties           Property           System.DirectoryServices.
                                          PropertyCollection
                                          Properties {get;}
  SchemaClassName      Property           System.String SchemaClass
                                          Name {get;}
  SchemaEntry          Property           System.DirectoryServices.
                                          DirectoryEntry SchemaEntry
                                          {get;}
  Site                 Property           System.ComponentModel.ISite
                                          Site {get;set;}
  UsePropertyCache     Property           System.Boolean UseProperty
                                          Cache {get;set;}
  Username             Property           System.String Username
                                          {get;set;}
```

Reading Properties

The convention is that object properties are read using a dot, just like all other objects (see Chapter 6). So, if you want to find out what is in the *Description* property of the *$useraccount* object, formulate:

```
$useraccount.Description

  Predefined account for guest access
```

But there are also two other options and they look like this:

```
$useraccount.Get("Description")
$useraccount.psbase.InvokeGet("Description")
```

At first glance, both seem to work identically. However, differences become evident when you query another property: *AccountDisabled*.

```
$useraccount.AccountDisabled
$useraccount.Get("AccountDisabled")

  Exception calling "Get" with 1 Argument(s):
  "The directory property cannot be found in the cache."
  At line:1 Char:14
```

```
    + $useraccount.Get( <<<< "AccountDisabled")

  $useraccount.psbase.InvokeGet("AccountDisabled")

    False
```

The first variant returns no information at all, the second an error message, and only the third the right result. What happened here?

The object in *$useraccount* is an object processed by PowerShell. All attributes (directory properties) become visible in this object as properties. However, ADSI objects can contain additional properties, and among these is *AccountDisabled*. PowerShell doesn't take these additional properties into consideration. The use of a dot categorically suppresses all errors as only *Get()* reports the problem: nothing was found for this element in the LDAP directory under the name *AccountDisabled*.

In fact, *AccountDisabled* is located in another interface of the element as only the underlying *PSBase* object, with its *InvokeGet()* method, does everything correctly and returns the contents of this property.

tip

As long as you want to work on properties that are displayed when you use *Format-List* * to output the object to the console, you won't have any difficulty using a dot or *Get()*. For all other properties, you'll have to use *PSBase.InvokeGet()*.Use *GetEx() i*If you want to have the contents of a property returned as an array.

Modifying Properties

In a rudimentary case, you can modify properties like any other object: use a dot to assign a new value to the property. Don't forget afterwards to call *SetInfo()* so that the modification is saved. That's a special feature of ADSI. For example, the following line adds a standard description for all users in the user directory if there isn't already one:

```
  $ldap = "CN=Users"
  $domain = [ADSI]""
  $dn = $domain.distinguishedName
  $users = [ADSI]"LDAP://$ldap,$dn"
  $users.PSBase.Children |
    Where-Object { $_.sAMAccountType -eq 805306368 } |
    Where-Object { $_.Description.toString() -eq "" } |
    ForEach-Object { $_.Description = "Standard description"; `
      $_.SetInfo(); $_.sAMAccountName + " was changed." }
```

In fact, there are also a total of three approaches to modifying a property. That will soon become very important as the three ways behave differently in some respects:

```
  $searchuser = Get-LDAPUser Guest
  $useraccount = $searchuser.GetDirectoryEntry()
```

```
# Method 1:
$useraccount.Description = "A new description"
$useraccount.SetInfo()
# Method 2:
$useraccount.Put("Description", "Another new description")
$useraccount.SetInfo()
# Method 3:
$useraccount.PSBase.InvokeSet("Description", "A third description")
$useraccount.SetInfo()
```

As long as you change the normal directory attributes of an object, all three methods will work in the same way. Difficulties arise when you modify properties that have special functions. For example among these is the *AccountDisabled* property, which determines whether an account is disabled or not. The *Guest* account is normally disabled:

```
$useraccount.AccountDisabled
```

The result is "nothing" because this property is—as you already know from the last section—not one of the directory attributes that PowerShell manages in this object. That's not good because something very peculiar will occur in PowerShell if you now try to set this property to another value:

```
$useraccount.AccountDisabled = $false
$useraccount.SetInfo()

  Exception calling "SetInfo" with 0 Argument(s):
  "The specified directory service attribute or value
  already exists. (Exception from HRESULT: 0x8007200A)"
  At line:1 Char:18
  + $useraccount.SetInfo( <<<< )

$useraccount.AccountDisabled

  False
```

PowerShell has summarily input to the object a new property called *AccountDisabled.* If you try to pass this object to the domain, it will resist: the *AccountDisabled* property added by PowerShell does not match the *AccountDisabled* domain property. This problem always occurs when you want to set a property of an ADSI object that hadn't previously been specified.

To eliminate the problem, you have to first return the object to its original state so you basically remove the property that PowerShell added behind your back. You can do that by using *GetInfo()* to reload the object from the domain. This shows that *GetInfo()* is the opposite member of *SetInfo()*:

```
$useraccount.GetInfo()
```

note

Once PowerShell has added an "illegal" property to the object, all further attempts will fail to store this object in the domain by using *SetInfo()*. You *must* call *GetInfo()* or create the object again.

Finally, use the third above-mentioned variant to set the property, namely not via the normal object processed by PowerShell, but via its underlying raw version:

```
$useraccount.psbase.InvokeSet("AccountDisabled", $false)
$useraccount.SetInfo()
```

Now the modification works. The lesson: the only method that can reliably and flawlessly modify properties is *InvokeSet()* from the underlying *PSBase* object. The other two methods that modify the object processed by PowerShell will only work properly with the properties that the object does display when you output it to the console.

Deleting Properties

If you want to completely delete a property, you don't have to set its contents to 0 or empty text. If you delete a property, it will be completely removed. *PutEx()* can delete properties and also supports properties that store arrays. *PutEx()* requires three arguments. The first specifies what *PutEx()* is supposed to do and corresponds to the values listed in Table 19.2. The second argument is the property name that is supposed to be modified. Finally, the third argument is the value that you assign to the property or want to remove from it.

Numerical Value	**Meaning**
1	Delete property value (property remains intact)
2	Replace property value completely
3	Add information to a property
4	Delete parts of a property

Table 19.2: PutEx() operations

To completely remove the *Description* property, use *PutEx()* with these parameters:

```
$useraccount.PutEx(1, "Description", 0)
$useraccount.SetInfo()
```

Then, the *Description* property will be gone completely when you call all the properties of the object:

```
$useraccount | Format-List *

  objectClass              : {top, person, organizationalPerson,
                             user}
  cn                       : {Guest}
```

```
distinguishedName         : {CN=Guest,CN=Users,DC=scriptinternals,
                            DC=technet}
instanceType              : {4}
whenCreated               : {11.12.2005 12:31:31}
whenChanged               : {17.10.2007 11:59:36}
uSNCreated                : {System.__ComObject}
memberOf                  : {CN=Guests,CN=Builtin,DC=scriptintern
                            als,DC=technet}
uSNChanged                : {System.__ComObject}
name                      : {Guest}
objectGUID                : {240 255 168 180 1 206 85 73 179 24
                            192 164 100 28 221 74}
userAccountControl        : {66080}
badPwdCount               : {0}
codePage                  : {0}
countryCode               : {0}
badPasswordTime           : {System.__ComObject}
lastLogoff                : {System.__ComObject}
lastLogon                 : {System.__ComObject}
logonHours                : {255 255 255 255 255 255 255 255 255
                            255 255 255 255 255 255 255 255 255
                            255 255 255}
pwdLastSet                : {System.__ComObject}
primaryGroupID            : {514}
objectSid                 : {1 5 0 0 0 0 0 5 21 0 0 0 184 88 34
                            189 250 183 7 172 165 75 78 29 245 1
                            0 0}
accountExpires            : {System.__ComObject}
logonCount                : {0}
sAMAccountName            : {Guest}
sAMAccountType            : {805306368}
objectCategory            : {CN=Person,CN=Schema,CN=Configur
                            ation,DC=scriptinternals,DC=technet}
isCriticalSystemObject    : {True}
nTSecurityDescriptor      : {System.__ComObject}
```

important

Even Get-Member won't return to you any more indications of the *Description* property. That's a real deficiency as you have no way to recognize what other properties the ADSI object may possibly support as long as you're using PowerShell's own resources. PowerShell always shows only properties that are defined.

However, this doesn't mean that the *Description* property is now gone forever. You can create a new one any time:

```
$useraccount.Description = "New description"
$useraccount.SetInfo()
```

Interesting, isn't it? This means you could add entirely different properties that the object didn't have before:

```
$useraccount.wwwHomePage = "http://www.powershell.com"
$useraccount.favoritefood = "Meatballs"

  Cannot set the Value property for PSMemberInfo
  object of type "System.Management.Automation.PSMethod".
  At line:1 Char:11
  + $useraccount.L <<<< oritefood = "Meatballs"

$useraccount.SetInfo()
```

It turns out that the user account accepts the *wwwHomePage* property (and so sets the Web page of the user on user properties), while "favoritefood" was rejected. Only properties allowed by the schema can be set.

The Schema of Domains

The directory service comes equipped with a list of permitted data called a *Schema* to prevent meaningless garbage from getting stored in the directory service. Some information is mandatory and has to be specified for every object of the type, others (like a home page) are optional. The internal list enables you to get to the properties that you may deposit in an ADSI object. The *SchemaClass* property will tell you which "operating manual" you need for the object:

```
$useraccount.psbase.SchemaClassName
user
```

Take a look under this name in the schema of the domain. The result is the schema object for user objects, which returns the names of all permitted properties in *SystemMayContain*.

```
$schema = $domain.PSBase.Children.find(
  "CN=user,CN=Schema,CN=Configuration")
$schema.systemMayContain | Sort-Object

  accountExpires
  aCSPolicyName
  adminCount
  badPasswordTime
  badPwdCount
  businessCategory
  codepage
  controlAccessRights
  dBCSPwd
  defaultClassStore
  desktopProfile
  dynamicLDAPServer
  groupMembershipSAM
  groupPriority
  groupsToIgnore
```

homeDirectory
homeDrive
homePhone
initials
lastLogoff
lastLogon
lastLogonTimestamp
lmPwdHistory
localeID
lockoutTime
logonCount
logonHours
logonWorkstation
mail
manager
maxStorage
mobile
msCOM-UserPartitionSetLink
msDRM-IdentityCertificate
msDS-Cached-Membership
msDS-Cached-Membership-Time-Stamp
mS-DS-CreatorSID
msDS-Site-Affinity
msDS-User-Account-Control-Computed
msIIS-FTPDir
msIIS-FTPRoot
mSMQDigests
mSMQDigestsMig
mSMQSignCertificates
mSMQSignCertificatesMig
msNPAllowDialin
msNPCallingStationID
msNPSavedCallingStationID
msRADIUSCallbackNumber
msRADIUSFramedIPAddress
msRADIUSFramedRoute
msRADIUSServiceType
msRASSavedCallbackNumber
msRASSavedFramedIPAddress
msRASSavedFramedRoute
networkAddress
ntPwdHistory
o
operatorCount
otherLoginWorkstations
pager
preferredOU
primaryGroupID
profilePath
pwdLastSet
scriptPath
servicePrincipalName
terminalServer

```
    unicodePwd
    userAccountControl
    userCertificate
    userParameters
    userPrincipalName
    userSharedFolder
    userSharedFolderOther
    userWorkstations
```

Setting Properties Having Several Values

PutEx() is not only the right tool for deleting properties but also for properties that have more than one value. Among these is *otherHomePhone*, the list of a user's supplementary telephone contacts. The property can store just one telephone number or several, which is how you can reset the property telephone numbers:

```
$useraccount.PutEx(2, "otherHomePhone", @("123", "456", "789"))
$useraccount.SetInfo()
```

But note that this would delete any other previously entered telephone numbers. If you want to add a new telephone number to an existing list, proceed as follows:

```
$useraccount.PutEx(3, "otherHomePhone", @("555"))
$useraccount.SetInfo()
```

A very similar method allows you to delete selected telephone numbers on the list:

```
$useraccount.PutEx(4, "otherHomePhone", @("456", "789"))
$useraccount.SetInfo()
```

Invoking Methods

All the objects that you've been working with up to now contain not only properties, but also methods. In contrast to properties, methods do not require you to call *SetInfo()* when you invoke a method that modifies an object. To find out which methods an object contains, use *Get-Member* to make them visible (see Chapter 6):

```
$guest | Get-Member -memberType *Method
```

Surprisingly, the result is something of a disappointment because the ADSI object PowerShell delivers contains no methods. The true functionality is in the base object, which you get by using *PSBase*:

```
$guest.psbase | Get-Member -memberType *Method

      TypeName: System.Management.Automation.PSMemberSet
   Name                          MemberType Definition
   ----                          ---------- ----------
```

```
add_Disposed              Method     System.Void add_Disposed
                                     (EventHandler value)
Close                     Method     System.Void Close()
CommitChanges             Method     System.Void CommitChanges
                                     ()
CopyTo                    Method     System.DirectoryServices.
                                     DirectoryEntry CopyTo(Dir
                                     ectoryEntry newPare...
CreateObjRef              Method     System.Runtime.Remoting.
                                     ObjRef CreateObjRef(Type
                                     requestedType)
DeleteTree                Method     System.Void DeleteTree()
Dispose                   Method     System.Void Dispose()
Equals                    Method     System.Boolean Equals(
                                     Object obj)
GetHashCode               Method     System.Int32 GetHashCode
                                     ()
GetLifetimeService        Method     System.Object GetLifetime
                                     Service()
GetType                   Method     System.Type GetType()
get_AuthenticationType    Method     System.DirectoryServices.
                                     AuthenticationTypes get_
                                     AuthenticationType()
get_Children              Method     System.DirectoryServices.
                                     DirectoryEntries get_
                                     Children()
get_Container             Method     System.ComponentModel.
                                     IContainer get_Container
                                     ()
get_Guid                  Method     System.Guid get_Guid()
get_Name                  Method     System.String get_Name()
get_NativeGuid            Method     System.String get_Native
                                     Guid()
get_ObjectSecurity        Method     System.DirectoryServices.
                                     ActiveDirectorySecurity
                                     get_ObjectSecurity()
get_Options               Method     System.DirectoryServices.
                                     DirectoryEntryConfigura
                                     tion get_Options()
get_Parent                Method     System.DirectoryServices.
                                     DirectoryEntry get_
                                     Parent()
get_Path                  Method     System.String get_Path()
get_Properties            Method     System.DirectoryServices.
                                     PropertyCollection get_
                                     Properties()
get_SchemaClassName       Method     System.String get_Schema
                                     ClassName()
get_SchemaEntry           Method     System.DirectoryServices.
                                     DirectoryEntry get_
                                     SchemaEntry()
get_Site                  Method     System.ComponentModel.
                                     ISite get_Site()
```

```
get_UsePropertyCache       Method     System.Boolean get_Use
                                      PropertyCache()
get_Username               Method     System.String get_User
                                      name()
InitializeLifetimeService Method     System.Object Initialize
                                      LifetimeService()
Invoke                     Method     System.Object Invoke(
                                      String methodName,
                                      Params Object[] args)
InvokeGet                  Method     System.Object InvokeGet(
                                      String propertyName)
InvokeSet                  Method     System.Void InvokeSet(
                                      String propertyName,
                                      Params Object[] args)
MoveTo                     Method     System.Void MoveTo(Direct
                                      oryEntry newParent),
                                      System.Void MoveTo(Dire...
RefreshCache               Method     System.Void RefreshCache(),
                                      System.Void RefreshCache(
                                      String[] propert...
remove_Disposed            Method     System.Void remove_Dis
                                      posed(EventHandler value)
Rename                     Method     System.Void Rename(String
                                      newName)
set_AuthenticationType     Method     System.Void set_Authentic
                                      ationType(Authentication
                                      Types value)
set_ObjectSecurity         Method     System.Void set_ObjectSec
                                      urity(ActiveDirectorySec
                                      urity value)
set_Password               Method     System.Void set_Password
                                      (String value)
set_Path                   Method     System.Void set_Path(
                                      String value)
set_Site                   Method     System.Void set_Site(
                                      ISite value)
set_UsePropertyCache       Method     System.Void set_Use
                                      PropertyCache(Boolean
                                      value)
set_Username               Method     System.Void set_Username(
                                      String value)
ToString                   Method     System.String ToString()
```

Changing Passwords

The password of a user account is an example of information that isn't stored in a property. That's why you can't just read out user accounts. Instead, methods ensure the immediate generation of a completely confidential hash value out of the user account and that it is deposited in a secure location. You can use the *SetPassword()* and *ChangePassword()* methods to change passwords:

```
$useraccount.SetPassword("New password")
```

```
$useraccount.ChangePassword("Old password", "New password")
```

note

Here, too, the deficiencies of *Get-Member* become evident when it is used with ADSI objects because *Get-Member* suppresses both methods instead of displaying them. You just have to "know" that they exist.

SetPassword() requires administrator privileges and simply resets the password. That can be risky because in the process you lose access to all your certificates outside a domain, including the crucial certificate for the Encrypting File System (EFS), though it's necessary when users forget their passwords. *ChangePassword* doesn't need any higher level of permission because confirmation requires giving the old password.

When you change a password, be sure that it meets the demands of the domain. Otherwise, you'll be rewarded with an error message like this one:

```
Exception calling "SetPassword" with 1 Argument(s):
"The password does not meet the password policy
requirements. Check the minimum password length,
password complexity and password history requirements.
(Exception from HRESULT: 0x800708C5)"
At line:1 Char:22
+ $realuser.SetPassword( <<<< "secret")
```

Controlling Group Memberships

Methods also set group memberships. Of course, the first thing you need is the groups in which a user becomes a member. That basically works just like user accounts as you could specify the ADSI path to a group to access the group. Alternatively, you can use a universal function that helpfully picks out groups for you:

```
function Get-LDAPGroup([string]$UserName, [string]$Start)
{
  # Use current logon domain:
  $domain = [ADSI]""
  # OR: log on to another domain:
  #   $domain = New-Object DirectoryServices.DirectoryEntry(
  #   "LDAP://10.10.10.1","domain\user", "secret")
  If ($start -ne "")
  {
    $startelement = $domain.psbase.Children.Find($start)
  }
  else
  {
    $startelement = $domain
  }
  $searcher = New-Object DirectoryServices.DirectorySearcher($startelement)
```

```
    $searcher.filter = "(&(objectClass=group)(sAMAccountName=$UserName))"
    $Searcher.CacheResults = $true
    $Searcher.SearchScope = "Subtree"
    $Searcher.PageSize = 1000
    $searcher.findall()
  }
```

In Which Groups Is a User a Member?

There are two sides to group memberships. Once you get the user account object, the *memberOf* property will return the groups in which the user is a member:

```
  $guest = (Get-LDAPUser Guest).GetDirectoryEntry()
  $guest.memberOf

    CN=Guests,CN=Builtin,DC=scriptinternals,DC=technet
```

Which Users Are Members of a Group?

The other way of looking at it starts out from the group: members are in the *Member* property in group objects:

```
  $admin = (Get-LDAPGroup "Domain Admins").GetDirectoryEntry()
  $admin.member

    CN=Tobias Weltner,CN=Users,DC=scriptinternals,DC=technet
    CN=Markus2,CN=Users,DC=scriptinternals,DC=technet
    CN=Belle,CN=Users,DC=scriptinternals,DC=technet
    CN=Administrator,CN=Users,DC=scriptinternals,DC=technet
```

tip

Groups on their part can also be members in other groups. So, every group object has not only the *Member* property with its members, but also *memberOf* with the groups in which this group is itself a member.

Adding Users to a Group

To add a new user to a group, you need the group object as well as (at least) the ADSI path of the user, who is supposed to become a member. To do this, use *Add()*:

```
  $administrators = (Get-LDAPGroup "Domain Admins").GetDirectoryEntry()
  $user = (Get-LDAPUser Cofi1).GetDirectoryEntry()
  $administrators.Add($user.psbase.Path)
  $administrators.SetInfo()
```

In the example, the user Cofi1 is added to the group of *Domain Admins*. It would have sufficed to specify the user's correct ADSI path to the *Add()* method. But it's easier to get the user and pass the path property of the *PSBase* object.

Aside from *Add()*, there are other ways to add users to groups:

```
$administrators.Member = $administrators.Member + $user.distinguishedName
$administrators.SetInfo()
$administrators.Member += $user.distinguishedName
$administrators.SetInfo()
```

Instead of *Add()* use the *Remove()* method to remove users from the group again.

Creating New Objects

The containers at the beginning of this chapter also know how to handle properties and methods. So, if you want to create new organizational units, groups, and users, all you have to do is to decide where these elements should be stored inside a domain. Then, use the *Create()* method of the respective container.

Creating New Organizational Units

Let's begin experimenting with new organizational units that are supposed to represent the structure of a company. Since the first organizational unit should be created on the topmost domain level, get a domain object:

```
$domain = [ADSI]""
```

Next, create a new organizational unit called "company" and under it some additional organizational units:

```
$company = $domain.Create("organizationalUnit", "OU=Idera")
$company.SetInfo()
$sales = $company.Create("organizationalUnit", "OU=Sales")
$sales.SetInfo()
$marketing = $company.Create("organizationalUnit", "OU=Marketing")
$marketing.SetInfo()
$service = $company.Create("organizationalUnit", "OU=Service")
$service.SetInfo()
```

Create New Groups

Groups can be created as easily as organizational units. You should decide again in which container the group is to be created and specify the name of the group. In addition, define with the *groupType* property the type of group that you want to create, because in contrast to organizational units there are several different types of groups:

Group	**Code**
Global	2
Local	4
Universal	8
As security group	Add -2147483648

Table 19.3: Group Types

Security groups have their own security ID so you can assign permissions to them. Distribution groups organize only members, but have no security function. In the following example, a global security group and a global distribution group are created:

```
$group_marketing = $marketing.Create("group", "CN=Marketinglights")
$group_marketing.psbase.InvokeSet("groupType", -2147483648 + 2)
$group_marketing.SetInfo()
$group_newsletter = $company.Create("group", "CN=Newsletter")
$group_newsletter.psbase.InvokeSet("groupType", 2)
$group_newsletter.SetInfo()
```

Creating New Users

To create a new user, proceed analogously, and first create the new user object in a container of your choice. Then, you can fill out the required properties and set the password using *SetPassword().* Using the *AccountDisabled* property, enable the account. The following lines create a new user account in the previously created organization unit "Sales":

```
$user = $sales.Create("User", "CN=MyNewUser")
$user.SetInfo()
$user.Description = "My New User"
$user.SetPassword("TopSecret99")
$user.psbase.InvokeSet('AccountDisabled', $false)
$user.SetInfo()
```

note

Instead of *Create()* use the *Delete()* method to delete objects.

CHAPTER 20.

Your Own Cmdlets and Extensions

Since PowerShell is layered on the .NET framework, you already know from Chapter 6 how you can use .NET code in PowerShell to make up for missing functions. In this chapter, we'll take up this idea once again. You'll learn about the options PowerShell has for creating command extensions on the basis of the .NET framework. You should be able to even create your own cmdlets at the end of this chapter.

Topics Covered:

Compiling Your Own .NET Expansions

Many functionalities of the .NET framework are available right in PowerShell. For example, the following two lines suffices to set up a dialog window:

```
[System.Reflection.Assembly]::`
LoadWithPartialName("Microsoft.VisualBasic")
[Microsoft.VisualBasic.Interaction]::`
MsgBox("Do you agree?", "YesNoCancel,Question", "Question")
```

In Chapter 6, you learned in detail about how this works and what an "assembly" is. To briefly explain what happened here, PowerShell used *LoadWithPartialName()* to load a system library and was then able to use the classes from it to call a static method like *MsgBox()*.

That's extremely practical when there is already a system library that offers the method you're looking for, but for some functionality even the .NET framework doesn't have any right commands. For example, you have to rely on your own resources if you want to move text to the clipboard. The only way to get it done is to access the low-level API functions outside the .NET framework.

Extension for the Clipboard

As soon as you need more than just a few lines of code or access to API functions to implement the kinds of extensions you want, it makes sense to write the extension directly in .NET program code. The following example shows how a method called *CopyToClipboard()* might look in VB.NET. The VB.NET code is directly assigned in the form of a *Here string* to the *$code* variable:

```
$code = @'
Imports Microsoft.VisualBasic
Imports System
Namespace ClipboardAddon
  Public Class Utility
    Private Declare Function OpenClipboard Lib "user32" _
      (ByVal hwnd As Integer) As Integer
    Private Declare Function EmptyClipboard Lib "user32" _
      () As Integer
    Private Declare Function CloseClipboard Lib "user32" _
      () As Integer
    Private Declare Function SetClipboardData Lib "user32" _
      (ByVal wFormat As Integer, ByVal hMem As Integer) As Integer
    Private Declare Function GlobalAlloc Lib "kernel32" _
      (ByVal wFlags As Integer, ByVal dwBytes As Integer) As Integer
    Private Declare Function GlobalLock Lib "kernel32" _
      (ByVal hMem As Integer) As Integer
    Private Declare Function GlobalUnlock Lib "kernel32" _
      (ByVal hMem As Integer) As Integer
    Private Declare Function lstrcpy Lib "kernel32" (ByVal _
      lpString1 As Integer, ByVal lpString2 As String) As Integer
    Public Sub CopyToClipboard(ByVal text As String)
      Dim result As Boolean = False
      Dim mem As Integer = GlobalAlloc(&H42, text.Length + 1)
      Dim lockedmem As Integer = GlobalLock(mem)

      lstrcpy(lockedmem, text)
      If GlobalUnlock(mem) = 0 Then
        If OpenClipboard(0) Then
          EmptyClipboard()
          result = SetClipboardData(1, mem)
          CloseClipboard()
        End If
      End If
    End Sub
  End Class
End Namespace
'@
```

You have to first compile the code before PowerShell can execute it. Compilation is a translation of your source code into machine-readable intermediate language (IL). There are two options here.

In-Memory Compiling

In a very simple case, you can task PowerShell to use *CompileAssemblyFromSource()* to translate your source code directly in a memory. The result is a new .NET assembly. As soon as the assembly is compiled, PowerShell can use the methods in it as well as *CopyToClipboard()* to move text to the clipboard:

```
$provider = New-Object Microsoft.VisualBasic.VBCodeProvider
$params = New-Object System.CodeDom.Compiler.CompilerParameters
$params.GenerateInMemory = $True
$refs = "System.dll","Microsoft.VisualBasic.dll"
$params.ReferencedAssemblies.AddRange($refs)
$results = $provider.CompileAssemblyFromSource($params, $code)
$object = New-Object clipboardaddon.Utility
$object.CopyToClipboard("Hi Everyone!")
```

pro tip

You might be asking yourself why you have to use *New-Object* first to create a new object in order to call your *CopyToClipboard()* method? That wasn't necessary in the first example of the *MsgBox()* method.

CopyToClipboard() is created in your source code as a *dynamic* method, which requires you to first create an instance of the class, and that's exactly what *New-Object* does. Then the instance can call the method.

Alternatively, methods can also be *static*. For example, *MsgBox()* in the first example is a static method. To call static methods, you need neither *New-Object* nor any instances. Static methods are called directly through the class in which they are defined.

If you would rather use *CopyToClipboard()*as a static method, all you need to do is to make a slight change to your source code. Replace this line:

```
Public Sub CopyToClipboard(ByVal text As String)
```

Type this line instead:

```
Public Shared Sub CopyToClipboard(ByVal text As String)
```

Once you have compiled your source code, then you can immediately call the method like this:

```
$provider = New-Object Microsoft.VisualBasic.VBCodeProvider
$params = New-Object System.CodeDom.Compiler.CompilerParameters
$params.GenerateInMemory = $True
$refs = "System.dll","Microsoft.VisualBasic.dll"
$params.ReferencedAssemblies.AddRange($refs)
$results = $provider.CompileAssemblyFromSource($params, $code)
[clipboardaddon.Utility]::CopyToClipboard("Hi Everyone!")
```

DLL Compilation

You'll lose your compilation in the memory as soon as you end PowerShell, which means you would have to do everything all over again every time you need the *CopyToClipboard()* method. An often better approach is to compile your source code in a Dynamic Link Library (DLL), whose file can then be loaded whenever you need it or passed on to friends and colleagues.

To make a DLL file from your source code, call the *vbc.exe* VB.NET compiler directly:

```
$code | Out-File sourcecode.vb
$path = Resolve-Path sourcecode.vb
$compiler = "$env:windir/Microsoft.NET/Framework/v2.0.50727/vbc"
&$compiler /target:library $path
dir sourcecode.dll
```

The result is the *sourcecode.dll* file. If you want to put it to work, all you have left to do now is to use *LoadFrom()* to load it in PowerShell:

```
$path = Resolve-Path sourcecode.dll
[System.Reflection.Assembly]::LoadFrom($path)
$object = New-Object clipboardaddon.Utility
$object.CopyToClipboard("Hi Everyone!")
```

pro tip

If you'd rather compile c# code, simply use the *csc.exe* c# compiler instead of *vbc.exe*. Use *LoadFrom()* if you want to load assemblies from any DLLs again and *LoadWithPartialName()* if you want to load system assemblies that are registered in the central .NET Global Assembly Cache (GAC).

Building Your Own Cmdlets

Command extensions based on DLLs that you compile yourself are an interesting alternative, but somewhat unwieldy. You would have to already know exactly where to find the DLL, use *LoadFrom()* to load it, and still have to know which method in the assembly is the right one. A further disadvantage is that methods from external DLLs don't support the PowerShell pipeline.

Your command extension will work much more conveniently if you turn it into a cmdlet. Your own new cmdlet will behave just like cmdlets that already exist. You can put it to work inside the pipeline, and it won't require any unusual method invocations.

How Cmdlets Are Structured

Every cmdlet represents a single command. These are wrapped as a package in the form of a snap-in so that PowerShell can use your cmdlets. The following example makes use of your clipboard function above in the *Out-Clipboard* cmdlet and wraps this in the *ClipboardSnapin* snap-in. A little later, it will be explained just how the following source code works. First, take a look at what steps are necessary to make this source code into a functioning cmdlet:

```
$code = @'
Imports System
Imports System.Configuration.Install
Imports System.Collections.Generic
Imports System.Text
Imports System.ComponentModel
Imports System.Management.Automation
Namespace MSPressBuch.PowerShell.Cmdlets
  <RunInstaller(True)> Public Class ClipboardSnapin
    Inherits PSSnapIn
    Public Sub New()
      MyBase.New()
    End Sub
    Public Overrides ReadOnly Property Name() As String
      Get
        Return "Clipboard-Tool"
      End Get
    End Property
    Public Overrides ReadOnly Property Vendor() As String
      Get
        Return "Dr. Tobias Weltner"
      End Get
    End Property
    Public Overrides ReadOnly Property VendorResource() As String
      Get
        Return String.Format("{0},{1}", Name, Vendor)
      End Get
    End Property
    Public Overrides ReadOnly Property Description() As String
      Get
        Return "Copy text to clipboard"
      End Get
    End Property
    Public Overrides ReadOnly Property _
    DescriptionResource() As String
      Get
        Return String.Format("{0},{1}", Name, Description)
      End Get
    End Property
  End Class

  <Cmdlet(VerbsData.Out, "Clipboard")> Public Class ClipboardHelper
    Inherits Cmdlet
    Private data As String = ""
    Private _Text() As String
    Private linefeed as string = ""
    <Parameter(Mandatory:=False, _
    Position:=0, _
    ValueFromPipeline:=True, _
    HelpMessage:="Text to copy to Clipboard"), _
    ValidateNotNullOrEmpty()> _
    Public Property Text() As String()
       Get
         Return _Text
       End Get
       Set(ByVal value As String())
         _Text = value
       End Set
    End Property
    Protected Overrides Sub BeginProcessing()
      WriteDebug("Enter BeginProcessing")
      data = ""
      MyBase.BeginProcessing()
    End Sub
    Protected Overrides Sub EndProcessing()
      WriteDebug("Enter EndProcessing")
      Utility.CopyToClipboard(data)
      MyBase.EndProcessing()
    End Sub
    Protected Overrides Sub ProcessRecord()
      WriteDebug("Processing Record")
      Try
        For Each Line As String In _Text
          data += Line
          data += linefeed
          linefeed = (chr(13) + chr(10))
        Next
      Catch ex as Exception
        WriteDebug("Failure: " & ex.Message)
      End Try
      WriteDebug("Done Processing Record")
    End Sub
  End Class
  Public Class Utility
    Private Declare Function OpenClipboard Lib "user32" _
      (ByVal hwnd As Integer) As Integer
    Private Declare Function EmptyClipboard Lib "user32" _
      () As Integer
    Private Declare Function CloseClipboard Lib "user32" _
      () As Integer
    Private Declare Function SetClipboardData Lib "user32" _
      (ByVal wFormat As Integer, ByVal hMem As Integer) _
      As Integer
    Private Declare Function GlobalAlloc Lib "kernel32" _
      (ByVal wFlags As Integer, ByVal dwBytes As Integer) _
      As Integer
    Private Declare Function GlobalLock Lib "kernel32" _
```

```
      (ByVal hMem As Integer) As Integer
    Private Declare Function GlobalUnlock Lib "kernel32" _
      (ByVal hMem As Integer) As Integer
    Private Declare Function lstrcpy Lib "kernel32" _
      (ByVal lpString1 As Integer, ByVal lpString2 As _
      String) As Integer

    Public Shared Sub CopyToClipboard(ByVal text As String)
      Dim result As Boolean = False
      Dim mem As Integer = GlobalAlloc(&H42, text.Length + 1)
      Dim lockedmem As Integer = GlobalLock(mem)
      lstrcpy(lockedmem, text)
      If GlobalUnlock(mem) = 0 Then
        If OpenClipboard(0) Then
          EmptyClipboard()
          result = SetClipboardData(1, mem)
          CloseClipboard()
        End If
      End If
   End Sub
  End Class
End Namespace
'@
```

Step 1: Compiling the Snap-In

As in the first examples, your source code must first be compiled. Again, use the *vbc.exe* VB.NET compiler. However, because your cmdlet uses classes like *Cmdlet* and *PSSnapIn*, which PowerShell provides, the compiler has to be given a reference to the PowerShell libraries. Use the */reference* switch to give this reference. The simplest way to find the location of the PowerShell libraries is to query the *Assembly.Location* property of the *PSObject* type.

```
$code | Out-File cmdlet.vb
$path = Resolve-Path cmdlet.vb
$compiler = "$env:windir/Microsoft.NET/Framework/v2.0.50727/vbc"
$ref = [PsObject].Assembly.Location
&$compiler /target:library /reference:$ref $path
dir cmdlet.dll

  Directory: Microsoft.PowerShell.Core\FileSystem::
  C:\Users\Tobias Weltner
  Mode                LastWriteTime     Length Name
  ----                -------------     ------ ----
  -a---        10.24.2007     12:13       8192 cmdlet.dll
```

If you haven't made any typing errors in *$code* of your source code, you'll get the file *cmdlet.dll*: your new snap-in, which includes your cmdlet.

Step 2: Registering Snap-Ins

Before you can use a snap-in, it has to be registered. The *installutil.exe* utility program of the .NET framework handles registration. Using it is roughly like using *regsvr32.exe* to register COM components in the old COM world. It makes some registry entries so that PowerShell can find your snap-in later.

Registering PowerShell snap-ins requires administrator privileges.

The following lines implement registration:

```
$path = Resolve-Path cmdlet.dll
$register = "$env:windir/Microsoft.NET/Framework/v2.0.50727/installutil"
&$register $path

  Microsoft (R) .NET Framework Installation utility Version
  2.0.50727.312
  Copyright (c) Microsoft Corporation. All rights reserved.
  Running a transacted installation.
  Beginning the Install phase of the installation.
  See the contents of the log file for the C:\Users\
  Tobias Weltner\cmdlet.dll assembly's progress.
  The file is located at C:\Users\Tobias Weltner\
  cmdlet.InstallLog.
  Installing assembly 'C:\Users\Tobias Weltner\cmdlet.dll'.
  Affected parameters are:
     logtoconsole =
     assemblypath = C:\Users\Tobias Weltner\cmdlet.dll
     logfile = C:\Users\Tobias Weltner\cmdlet.InstallLog
  The Install phase completed successfully, and the
  Commit phase is beginning.
  See the contents of the log file for the C:\Users\
  Tobias Weltner\cmdlet.dll assembly's progress.
  The file is located at C:\Users\Tobias Weltner\
  cmdlet.InstallLog.
  Installing assembly 'C:\Users\Tobias Weltner\cmdlet.dll'.
  Affected parameters:
     logtoconsole =
     assemblypath = C:\Users\Tobias Weltner\cmdlet.dll
     logfile = C:\Users\Tobias Weltner\cmdlet.InstallLog
  The Commit phase completed successfully.
  The transacted install has completed.
```

Step 3: Loading Snap-Ins

You use the *Get-PSSnapin* cmdlet to manage all registered snap-ins. This cmdlet allows you to find out which snap-ins that you are currently using:

```
Get-PSSnapin

  Name        : Microsoft.PowerShell.Core
  PSVersion   : 1.0
  Description : This Windows PowerShell snap-in contains Windows
                PowerShell management cmdlets used to manage
                components of Windows PowerShell.
  Name        : Microsoft.PowerShell.Host
  PSVersion   : 1.0
  Description : This Windows PowerShell snap-in contains cmdlets
                used by the Windows PowerShell host.
  Name        : Microsoft.PowerShell.Management
  PSVersion   : 1.0
  Description : This Windows PowerShell snap-in contains management
                cmdlets used to manage Windows components.
  Name        : Microsoft.PowerShell.Security
  PSVersion   : 1.0
  Description : This Windows PowerShell snap-in contains cmdlets to
                manage Windows PowerShell security.
  Name        : Microsoft.PowerShell.Utility
  PSVersion   : 1.0
  Description : This Windows PowerShell snap-in contains utility
                Cmdlets used to manipulate data.
```

As you see, all cmdlets come from snap-ins. Even the tightly built-in cmdlets are not at all as tightly built-in as it seems. When PowerShell starts, it loads them from various snap-ins. So, it might be that some additional snap-ins are on your system, such as to manage Microsoft Exchange or to perform other tasks.

But *Get-PSSnapin* not only displays snap-ins that are already loaded, but any others as well. Using the *-registered* parameter instructs *Get-PSSnapin* to list all registered snap-ins. Since you already registered your own snap-in, it should be in this list:

```
Get-PSSnapin -registered

  Name        : Clipboard-Tool
  PSVersion   : 1.0
  Description : Copy text to clipboard
  Name        : Pscx
  PSVersion   : 1.0
  Description : PowerShell Community Extensions (PSCX) base snapin
                which implements a general purpose set of cmdlets.
```

If you want to use a new snap-in, you have to load it using *Add-PSSnapin*. You need to do it once for every PowerShell session so, if you need the snap-in often, you should get it to automatically load right into one of your PowerShell profile scripts (see Chapter 10).

```
Add-PSSnapin Clipboard-Tool
```

As soon as the snap-in is loaded, all the cmdlets it contains will be available. You could call your new *Out-Clipboard* cmdlet to move text to the clipboard:

```
Out-Clipboard -text "Hi there"
Out-Clipboard "Hi there"
```

It may also be used inside the pipeline since your cmdlet supports the PowerShell pipeline. The next line will copy your output to the clipboard:

```
Dir | Out-Clipboard
```

However, if you insert text from the clipboard into a program like Notepad, you may ask why just the file name and not the complete directory listing are displayed.

The answer lies in the PowerShell pipeline, which, remember, transports objects. The result of *Dir* is individual objects, while *Out-Clipboard* is expecting text. That's why only one object property, the name, is passed onto the clipboard. If you really want to move the entire directory listing in the form in which it is normally displayed in the console to the clipboard, you should first use *Out-String* to convert the objects into text:

```
Dir | Out-String | Out-Clipboard
```

By the way, your new cmdlet also supports many other aspects of cmdlets like debugging messages. If you specify the *-debug* parameter, your cmdlet will output all the reports that were written to your source code using *WriteDebug()*. Depending on the debugging settings in *$debugpreference*, you can either have your computer ask you to confirm each step or just show yellow-colored debugging messages.

```
Out-Clipboard Hello -debug

  DEBUG: Enter BeginProcessing
  Confirm
  Continue action?
  |Y| Yes  |A| Yes to All  |H| Halt Command  |S| Suspend |?| Help (default is "Y"):
  y
  DEBUG: Processing Record
  Confirm
  Continue action?
  |Y| Yes  |A| Yes to All  |H| Halt Command  |S| Suspend |?| Help (default is "Y"):
  a
  DEBUG: Done Processing Record
  DEBUG: Enter EndProcessing
```

The Structure of Cmdlets

Now, let's look a little more closely at the source code of your cmdlet, which actually consists of three classes:

- **Snap-Ins:** The first class defines the snap-in, that is, the general container for all following cmdlets.
- **Cmdlet:** The second class defines the Out-Clipboard cmdlet.
- **Helper classes:** Finally, the third class corresponds to clipboard functionality and is used by the cmdlet to copy text to the clipboard.

The Snap-In

The snap-in enables installation of the cmdlet package using the *RunInstaller* attribute. The *installutil* registration tool can automatically enter this snap-in in the registry.

The second task of the snap-in is to retrieve information about maker, version, and function of the package. The *ClipboardSnapin* class is derived from the *PSSnapin* prototype using *Inherit* so that this information can be called for every snap-in while always using the same properties. This enables the class to be assigned standard properties that the class later defines more precisely using *Overrides*.

```
<RunInstaller(True)> Public Class ClipboardSnapin
  Inherits PSSnapIn
  Public Sub New()
    (...)
  End Sub
  Public Overrides ReadOnly Property Name() As String
    (...)
  End Property
  Public Overrides ReadOnly Property Vendor() As String
    (...)
  End Property
  Public Overrides ReadOnly Property VendorResource() As String
    (...)
  End Property
  Public Overrides ReadOnly Property Description() As String
    (...)
  End Property
  Public Overrides ReadOnly Property DescriptionResource() As String
    (...)
  End Property
End Class
```

The Cmdlet

The actual cmdlet is an additional class that is derived this time from the *Cmdlet* prototype. The *Cmdlet* attribute defines the name of the cmdlet. Only certain names are allowed as verbs because the names of all cmdlets obey strict naming rules. That's why the verb *out* comes from the *VerbsData* list, which sets the permitted name. In contrast, the noun part of the name can be freely selected and is specified as *Clipboard*. As a result, the complete name of this cmdlet is *Out-Clipboard*.

```
<Cmdlet(VerbsData.Out, "Clipboard")> Public Class ClipboardHelper
  Inherits Cmdlet
```

There follow the parameters of the cmdlet. In this case, only one parameter called *Text* is set. Its position is 0, which means that if no parameter name is specified, *Out-Clipboard* will bind the first specified argument to the parameter. For this reason, you may type both *Out-Clipboard -text Hello* and *Out-Clipboard Hello*.

So that your cmdlet can also get input from the pipeline, *ValueFromPipeline* is set to *True,*making it possible for you to use your cmdlet inside the pipeline: *Dir* | *Out-Clipboard*.

```
<Parameter(Mandatory:=False, Position:=0, ValueFromPipeline:=True, _
HelpMessage:="Text to copy to Clipboard"), ValidateNotNullOrEmpty()> _
Public Property Text() As String()
  Get
    Return _Text
  End Get
  Set(ByVal value As String())
    _Text = value
  End Set
End Property
```

Begin, Process, End

In conclusion, you should specify what will happen when your cmdlet is called. Like the functions we saw in Chapter 9, three phases must be distinguished. *BeginProcessing()* is called when the cmdlet is activated (initialization). *EndProcessing()* is called when the cmdlet has ended its work (tidying tasks). And *ProcessRecord()* is called for *every single* object that is passed to the cmdlet.

```
Protected Overrides Sub BeginProcessing()
  (...)
End Sub
Protected Overrides Sub EndProcessing()
  (...)
End Sub
Protected Overrides Sub ProcessRecord()
  (...)
End Sub
```

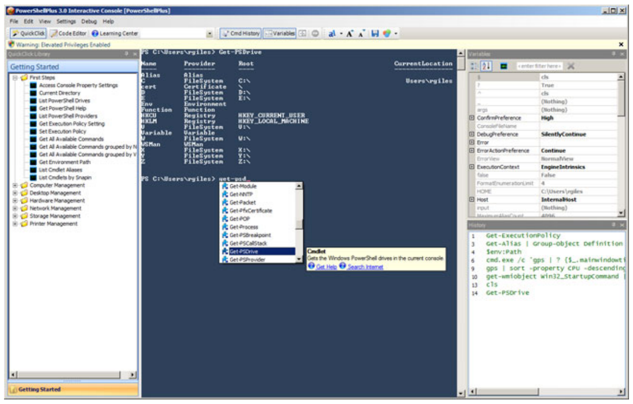
It is best for you to look at what happens in practice by calling your cmdlet using the *-debug* parameter, which enables you to read the debugging messages that are in your source text with *WriteDebug()* and that tell you exactly when each part was executed.

About Idera's PowerShell Plus

Architected and developed by Dr. Tobias Weltner, Idera's PowerShell Plus is the most advanced Interactive Development Environment for Windows PowerShell available today. Designed to help administrators and developers quickly learn and master Windows PowerShell, it also dramatically increases the productivity of expert users. Try PowerShell Plus free for 14-days and see how much more productive you can be!

PowerShell Plus Interactive Console

Enables you to work interactively with PowerShell from a feature rich Windows UI. This integration makes working with PowerShell faster and easier to use than ever before!



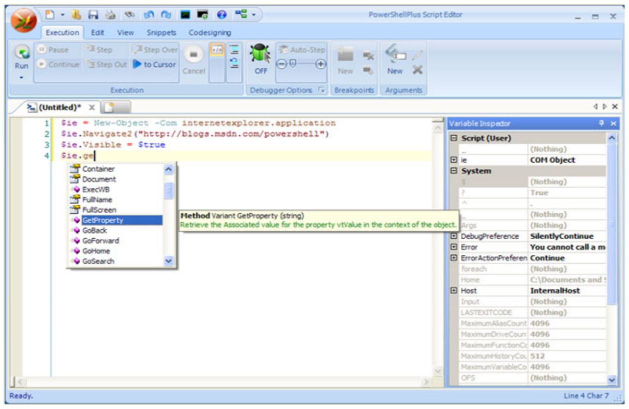
```
PS C:\Users\rgiles> Get-PSDrive

Name       Provider      Root                                   CurrentLocation
----       --------      ----                                   ---------------
Alias      Alias
C          FileSystem    C:\                                     Users\rgiles
cert       Certificate   \
D          FileSystem    D:\
E          FileSystem    E:\
Env        Environment
Function   Function
HKCU       Registry      HKEY_CURRENT_USER
HKLM       Registry      HKEY_LOCAL_MACHINE
U          FileSystem    U:\
Variable   Variable
W          FileSystem    W:\
WSMan      WSMan
X          FileSystem    X:\
Y          FileSystem    Y:\
Z          FileSystem    Z:\

PS C:\Users\rgiles> get-psd
```

Cmdlet
Gets the Windows PowerShell drives in the current console

```
1   Get-ExecutionPolicy
3   Get-Alias | Group-Object Definition
4   $env:Path
6   cmd.exe /c 'gps | ? {$_.mainwindowt
9   gps | sort -property CPU -descending
10  get-wmiobject Win32_StartupCommand
13  cls
14  Get-PSDrive
```

Advanced Script Editor

The advanced debugger and script editor lets you build and test complex PowerShell scripts, try one line PowerShell commands from an embedded console window, and sign your script with a security certificate… All from a single workspace!



```
$ie = New-Object -Com internetexplorer.application
$ie.Navigate2("http://blogs.msdn.com/powershell")
$ie.Visible = $true
$ie.ge
```

Method Variant GetProperty (string)
Retrieve the Associated value for the property vtValue in the context of the object.

Comprehensive Learning Center

The Comprehensive Learning Center helps you experience PowerShell by example. Short tutorials guide you through basic concepts at your own pace. The Comprehensive Learning Center also includes dynamically created help topics from currently installed PowerShell CmdLets, Snap-Ins and WMI objects.

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PowerShell Plus is the most advanced IDE for PowerShell available today. Designed to help administrators and developers quickly learn and master Windows PowerShell, it also dramatically increases the productivity of expert users. PowerShell Plus features a powerful interactive console, an advanced script editor and debugger and a comprehensive interactive learning center all integrated into a single product.

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» Practical PowerShell Video Series

» Latest Twitter Streams

» Concentrated Technology

» PowerShellCommunity.org