Effective Windows PowerShell

Grok Windows PowerShell and Get More From It.

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Table of Contents

Introduction

I am a big fan of the “Effective” series of programming books from *Effective COM* to *Effective XML*. Without trying to be too presumptuous, I wanted to capture some of the tidbits I have picked up over the last couple of years using Windows PowerShell interactively and writing production build and test scripts. These items were written for PowerShell 1.0. Where appropriate I have added *PowerShell 2.0 Update* sections to discuss how the item is affected by the upcoming 2.0 release. As a final note, a number of the PowerShell code snippets shown use functionality from the PowerShell Community Extensions which can be downloaded from http://www.codeplex.com/PowerShellCX.

Item 1: Four Cmdlets that are the Keys to Discovery within PowerShell

This first item is pretty basic and I debated whether or not it belongs in an "Effective PowerShell" article. However, these four cmdlets are critical to figuring out how to make PowerShell do your bidding and that makes them worth covering. The following four cmdlets are the first four that you should learn backwards and forwards. With these four simple-to-use cmdlets you can get started using PowerShell - effectively.

Key #1: Get-Command

This cmdlet is the sure cure to the blank, PowerShell prompt of death. That is, you just installed PowerShell, fired it up and you're left looking at this:

Now what? Many applications suffer from the "blank screen of death" i.e. you download the app, install it and run it and now you're presented with a blank canvas or an empty document. Often it isn't obvious how to get started using a new application. In PowerShell, what you need to get started is Get-Command to find all the commands that are available from PowerShell. This includes all your old console utilities, batch files, VBScript files, etc. Basically anything that is executable can be executed from PowerShell. Of course, you didn't download PowerShell just to run these old executables and scripts. You want to see what PowerShell can do. Try this:

```
PS> Get-Command

CommandType     Name                          Definition
-----------     ----                          ----------
Cmdlet          Add-Content                   Add-Content [-Path] <Stri...
...
```

```
Cmdlet          Get-Command                    Get-Command [[-ArgumentLi...
...
```

By default, Get-Command lists all the cmdlets that PowerShell provides. Notice that Get-Command is one of those cmdlets. Get-Command can list more information but how would you figure that out? This brings us to the second command you need to know and will be using frequently in PowerShell.

Key #2: Get-Help

The Get-Help cmdlet provides help on various topics including what a specified cmdlet does, what parameters it takes and usually includes examples of how to use the command. It will also provide help on general PowerShell topics like globbing and operators. Say you want to know what all the help topics are in PowerShell. That's easy, just do this:

```
PS> Get-Help *

Name                     Category                 Synopsis
----                     --------                 --------
ac                       Alias                    Add-Content
asnp                     Alias                    Add-PSSnapin
...
Get-Command              Cmdlet                   Gets basic informati...
Get-Help                 Cmdlet                   Displays information...
...
Alias                    Provider                 Provides access to t...
Environment              Provider                 Provides access to t...
FileSystem               Provider                 The PowerShell Provi...
Function                 Provider                 Provides access to t...
Registry                 Provider                 Provides access to t...
Variable                 Provider                 Provides access to t...
Certificate              Provider                 Provides access to X...
...
about_Globbing           HelpFile                 See Wildcard
about_History            HelpFile                 Retrieving commands ...
about_If                 HelpFile                 A language command f...
about_logical_Operator   HelpFile                 Operators that can b...
...
```

And if you only want to see the "about" help topics try this:

```
PS> Get-Help about*

Name                     Category                 Synopsis
----                     --------                 --------
about_Alias              HelpFile                 Using alternate name...
about_Arithmetic_Oper... HelpFile                 Operators that can b...
about_Array              HelpFile                 A compact data struc...
...
```

Now, let's try Get-Help on Get-Command and see what else we can do with Get-Command:

```
PS> Get-Help get-command -detailed


NAME
    Get-Command


SYNOPSIS
    Gets basic information about cmdlets and about other elements of Wind
    ows PowerShell commands.
...


PARAMETERS
    -name <string[]>
        Gets information only about the cmdlets or command elements with
        the specified name. <String> represents all or part of the name o
        f the cmdlet or command element. Wildcards are permitted.


    -verb <string[]>
        Gets information about cmdlets with names that include the specif
        ied verb. <String> represents one or more verbs or verb patterns,
         such as "remove" or *et". Wildcards are permitted.


    -noun <string[]>
        Gets cmdlets with names that include the specified noun. <String>
         represents one or more nouns or noun patterns, such as "process"
         or "*item*". Wildcards are permitted.


    -commandType <CommandTypes>
        Gets only the specified types of command objects. Valid values fo
        r <CommandTypes> are:
                  Alias                   ExternalScript
                  All                     Filter
                  Application             Function
                  Cmdlet (default)        Script
```

TIP: You will want to use the -Detailed parameter with Get-Help otherwise you get very minimal parameter information. Hopefully in PowerShell V3 they will fix the "default view" of cmdlet help topics to be a bit more informative. There are a couple of things to learn from the help topic. First, you can pass Get-Command a -CommandType parameter to list other types of commands. Let's try this to see what PowerShell functions are available by default:

```
PS> Get-Command -commandType function


CommandType     Name                            Definition
-----------     ----                            ----------
Function        A:                              Set-Location A:
Function        B:                              Set-Location B:
Function        C:                              Set-Location C:
Function        Clear-Host                      $spaceType = [System.Mana...
...
Function        help                            param([string]$Name,[stri...
```

```
...
Function        man                          param([string]$Name,[stri...
Function        md                           param([string[]]$paths); ...
Function        mkdir                        param([string[]]$paths); ...
Function        more                         param([string[]]$paths); ...
...
Function        prompt                       'PS ' + $(Get-Location) +...
...
```

Excellent. We could do the same for aliases, applications, external scripts, filters, and scripts. Also note that Get-Command allows you search for cmdlets based on either a Noun or a Verb. There's a more compact form that most of the PowerShell regulars use instead of these parameters though:

```
PS> Get-Command write-*

CommandType     Name                         Definition
-----------     ----                         ----------
Cmdlet          Write-Debug                  Write-Debug [-Message] <S...
Cmdlet          Write-Error                  Write-Error [-Message] <S...
Cmdlet          Write-Host                   Write-Host [[-Object] <Ob...
Cmdlet          Write-Output                 Write-Output [-InputObjec...
Cmdlet          Write-Progress               Write-Progress [-Activity...
Cmdlet          Write-Verbose                Write-Verbose [-Message] ...
Cmdlet          Write-Warning                Write-Warning [-Message] ...
```

You can swap the wildcard char to find all verbs associated with a particular noun (usually the more useful search):

```
PS> Get-Command *-object

CommandType     Name                         Definition
-----------     ----                         ----------
Cmdlet          Compare-Object               Compare-Object [-Referenc...
Cmdlet          ForEach-Object               ForEach-Object [-Process]...
Cmdlet          Group-Object                 Group-Object [[-Property]...
Cmdlet          Measure-Object               Measure-Object [[-Propert...
Cmdlet          New-Object                   New-Object [-TypeName] <S...
Cmdlet          Select-Object                Select-Object [[-Property...
Cmdlet          Sort-Object                  Sort-Object [[-Property] ...
Cmdlet          Tee-Object                   Tee-Object [-FilePath] <S...
Cmdlet          Where-Object                 Where-Object [-FilterScri...
```

Finally, we can pass a name to Get-Command to find out if this name will be interpreted as a command and if so, what type of command: alias, application, cmdlet, external script, filter, function or script. In this usage, Get-Command is like the UNIX *which* command on steroids. Let me show you what I mean:

```
PS> Get-Command more

CommandType     Name                            Definition
-----------     ----                            ----------
Function        more                            param([string[]]$paths); ...
Application     more.com                        C:\Windows\system32\more.com
```

Note that PowerShell tells me not only the location of applications like more.com, it also tells me what type of command each is (function vs. application) as well as the function's definition.

Note: *The output order in version 1 does not indicate which command PowerShell will execute when there are commands with the same name. This has been fixed in version 2*.

If you wanted to use the Windows more.com executable, you would need to use the command `more.com`. However, there is even more information to be found here than meets the eye. This brings us to our third key cmdlet – Get-Member.

Key #3: Get-Member

The single biggest concept that takes a while to sink in with most people using PowerShell for the first time is that just about everything is (or can be) a .NET object. That means when you pipe information from one cmdlet to another it quite often isn't text and if it is, it is still an object i.e. a *System.String* object. However, quite often it is some other type of object and being new to PowerShell, you may not know what type of object it is or what you can do with that object. Let's take a further look at what information (i.e. objects) Get-Command outputs. In order to do this, we will use Get-Member like so:

```
PS> Get-Command more.com | Get-Member


   TypeName: System.Management.Automation.ApplicationInfo

Name            MemberType     Definition
----            ----------     ----------
Equals          Method         System.Boolean Equals(Object obj)
GetHashCode     Method         System.Int32 GetHashCode()
GetType         Method         System.Type GetType()
ToString        Method         System.String ToString()
CommandType     Property       System.Management.Automation.CommandTyp...
Definition      Property       System.String Definition {get;}
Extension       Property       System.String Extension {get;}
Name            Property       System.String Name {get;}
Path            Property       System.String Path {get;}
FileVersionInfo ScriptProperty System.Object FileVersionInfo {get=[Sys...
```

Isn't this interesting. Unlike the UNIX *which* command that only gives us the path to the application, PowerShell gives a bit more information. Let's examine the FileVersionInfo property associated with this ApplicationInfo object:

```
PS> Get-Command more.com | Foreach {$_.FileVersionInfo}

ProductVersion   FileVersion      FileName
--------------   -----------      --------
6.0.6000.16386   6.0.6000.1638... C:\Windows\system32\more.com
```

This is just an inkling of the power of being able to access objects instead of information in unstructured, text form. Get-Member is also handy for discovering what properties and methods are available on .NET objects.

```
PS> Get-Date | Get-Member


   TypeName: System.DateTime

Name                 MemberType     Definition
----                 ----------     ----------
Add                  Method         System.DateTime Add(TimeSpan value)
AddDays              Method         System.DateTime AddDays(Double value)
AddHours             Method         System.DateTime AddHours(Double va...
AddMilliseconds      Method         System.DateTime AddMilliseconds(Do...
AddMinutes           Method         System.DateTime AddMinutes(Double ...
...
```

You can also find out information about static properties and methods like so:

```
PS> [System.Math] | Get-Member -static


   TypeName: System.Math

Name            MemberType Definition
----            ---------- ----------
Abs             Method     static System.Single Abs(Single value), sta...
Acos            Method     static System.Double Acos(Double d)
Asin            Method     static System.Double Asin(Double d)
Atan            Method     static System.Double Atan(Double d)
Atan2           Method     static System.Double Atan2(Double y, Double x)
BigMul          Method     static System.Int64 BigMul(Int32 a, Int32 b)
...
```

Key #4: Get-PSDrive

Another major concept in PowerShell that you need to grok is that the file system is just one of several types of drives that can be manipulated by the same cmdlets you use to manipulate the file system. How do you find out which drives are available in PowerShell? Use the Get-PSDrive command:

```
PS> Get-PSDrive

Name       Provider      Root                                       CurrentLocation
----       --------      ----                                       ---------------
Alias      Alias
C          FileSystem    C:\
```

```
cert        Certificate   \
D           FileSystem    D:\
E           FileSystem    E:\
Env         Environment
Function    Function
G           FileSystem    G:\
H           FileSystem    H:\
HKCU        Registry      HKEY_CURRENT_USER
HKLM        Registry      HKEY_LOCAL_MACHINE
M           FileSystem    M:\
Variable    Variable
```

All these drives can be manipulating using same cmdlets you use to manipulate the file system. What are those? Use Get-Command *-Item* to find out:

```
PS> Get-Command *-Item*

CommandType     Name                            Definition
-----------     ----                            ----------
Cmdlet          Clear-Item                      Clear-Item [-Path] <String[]...
Cmdlet          Clear-ItemProperty              Clear-ItemProperty [-Path] <...
Cmdlet          Copy-Item                       Copy-Item [-Path] <String[]>...
Cmdlet          Copy-ItemProperty               Copy-ItemProperty [-Path] <S...
Cmdlet          Get-Item                        Get-Item [-Path] <String[]> ...
Cmdlet          Get-ItemProperty                Get-ItemProperty [-Path] <St...
Cmdlet          Invoke-Item                     Invoke-Item [-Path] <String[...
Cmdlet          Move-Item                       Move-Item [-Path] <String[]>...
Cmdlet          Move-ItemProperty               Move-ItemProperty [-Path] <S...
Cmdlet          New-Item                        New-Item [-Path] <String[]> ...
Cmdlet          New-ItemProperty                New-ItemProperty [-Path] <St...
Cmdlet          Remove-Item                     Remove-Item [-Path] <String[...
Cmdlet          Remove-ItemProperty             Remove-ItemProperty [-Path] ...
Cmdlet          Rename-Item                     Rename-Item [-Path] <String>...
Cmdlet          Rename-ItemProperty             Rename-ItemProperty [-Path] ...
Cmdlet          Set-Item                        Set-Item [-Path] <String[]> ...
Cmdlet          Set-ItemProperty                Set-ItemProperty [-Path] <St...
```

There you have it. The four cmdlets that you **need** to know to effectively find your way around Windows PowerShell. Use Get-Command to find out what commands are available. Use Get-Help to find out how to use those commands and the PowerShell language. Use Get-Member to figure out what properties, methods and events are available on those .NET objects you'll be dealing with in PowerShell. Finally, use Get-PSDrive to find out which type of drives you can operate on besides the file system.

PowerShell 2.0 Update

Get-Command has been updated to display commands with the same name in the order in which PowerShell will execute them. If Get-Help can't find a topic title with the Name you specified, it will now search the help contents and list those topics where the specified name is found in the body of the help topic. Get-Member no longer displays compiler generated methods like get_Name/set_Name by default. If you really want to see the compiler generated methods you can use the –Force parameter.

Item 2: Understanding Output

In shells that you may have used in the past, everything that appears on the stdout and stderr streams is considered "the output". In these other shells you can typically redirect stdout to a file using the redirect operator >. And in some shells like Korn shell, you can capture stdout output to a variable like so:

```
DIRS=$(find . | sed.exe -e 's/\//\\/g')
```

If you wanted to capture stderr in addition to stdout then you can use the stream redirect operator like so:

```
DIRS=$(find . | sed.exe -e 's/\//\\/g' 2>&1)
```

You can do the same in PowerShell:

```
PS> $dirs = Get-ChildItem -recurse
PS> $dirs = Get-ChildItem -recurse 2>&1
```

Looks about the same in PowerShell so what's the big deal? Well there are a number of differences and subtleties in PowerShell that you need to be aware of.

Output is Always a .NET Object

First, remember that PowerShell output is always a .NET object. That output could be a *System.IO.FileInfo* object or a *System.Diagnostics.Process* object or a *System.String* object. Basically it could be any .NET object whose assembly is loaded into PowerShell including your own .NET objects. Be sure not to confuse PowerShell output with the text you see rendered to the screen. Later on in Item 6: Know Your Output Formatters I cover the notion that when a .NET object is about to "hit" the host (console) PowerShell uses some fancy formatting technology to try to determine the best "textual" representation for the object. However, when you capture output to a variable, you are not capturing the text that was rendered to the host. You are capturing the .NET object(s). Let's look at an example:

```
PS> Get-Process PowerShell

Handles  NPM(K)    PM(K)      WS(K) VM(M)   CPU(s)     Id ProcessName
-------  ------    -----      ----- -----   ------     -- -----------
    425       9    32660      16052   181    31.63   5128 powershell
```

Now let's capture that output and examine its type:

```
PS> $procs = Get-Process PowerShell
PS> $procs.GetType().Fullname
System.Diagnostics.Process
```

As you can see, a *System.Diagnostics.Process* object has been stored in $procs and not the text that was rendered to the screen. But what if we really wanted to capture the rendered text? In this case, we could use the Out-String cmdlet to render the output as a string which we could then capture in a variable e.g.:

```
PS> $procs = Get-Process PowerShell | Out-String
PS> $procs.GetType().Fullname
System.String
PS> $procs

Handles  NPM(K)    PM(K)      WS(K) VM(M)   CPU(s)     Id ProcessName
-------  ------    -----      ----- -----   ------     -- -----------
    479       9    32660      16052   181    31.72   5128 powershell
```

Another nice feature of Out-String is that it has a Width parameter that allows you to specify the maximum width of the text that is rendered. This is handy when there is wide output that you don't want wrapped or truncated to the width of your host.

Function Output Consists of Everything That Isn't Captured

I've seen this problem bite folks time and time again on the PowerShell newsgroup. It usually happens to those of us with programming backgrounds that are familiar with C style functions. What you need to be aware of is that in PowerShell, a function is a bit different. While a function in PowerShell does provide a separate scope for variables and a convenient way to invoke the same functionality multiple times without breaking the *DRY* principle, the way it deals with output can be confusing at first. Essentially a function handles output in the same way as any PowerShell script that isn't in a function. What does that mean? Let's look at an example.

```
PS> function bar {
>>          $procs = Get-Process svchost
>>          "Returning svchost process objects"
>>          return $procs
>>      }
>>
```

That should return an array of *System.Diagnostic.Process* objects, right? We told PowerShell to "return $procs". Let's check the output:

```
PS> $result = bar
PS> $result | foreach {$_.GetType().Fullname}
System.String
System.Diagnostics.Process
System.Diagnostics.Process
System.Diagnostics.Process
...
```

Whoa! Why is the first object *System.String*? Well a quick look at its value and you'll see why:

```
PS> $result[0]
Returning svchost process objects
```

Notice that the informational message we thought we were displaying to the host actually got returned as part of the output of the function. There are a couple of subtleties to understand here. First, the return keyword allows you to exit the function at any particular point. You may also "optionally" specify an argument to the return statement that will cause the argument to be output just before returning. `"return $procs"` does not mean that the function's only output is the contents of the $procs variable. In fact this construct is semantically equivalent to "`$procs; return`".

The second subtlety to understand is this. The line:

```
"Returning svchost process objects"
```

is equivalent to this:

```
Write-Output "Returning svchost process objects"
```

That makes it clear that the string is considered part of the function's output.

Now what if we wanted to make that information available to the end user but not the script consuming the output of the function? Then we could have used Write-Host like so:

```
PS> function bar {
>>     $Proc = Get-Process svchost
>>     Write-Host "Returning svchost process objects"
>>     return $Proc
>> }
>>
```

Write-Host does not contribute to the output of the function. It writes directly and immediately to the host. This might all seem obvious now but you have to be diligent when you write a PowerShell function to ensure you get only the output you want. This usually means redirecting unwanted output to $null (or optionally type casting the expression with the unwanted output to [void]). Here's an example:

```
PS> function LongNumericString {
>>     $strBld = new-object System.Text.StringBuilder
>>     for ($i=0; $i -lt 20; $i++) {
>>         $strBld.Append($i)
>>     }
>>     $strBld.ToString()
>> }
>>
```

Note that we don't need to use the return keyword like we do in C style function. Whatever expressions and statements that have output will contribute to the output of our function. This is part of a PowerShell function behaving like ordinary PowerShell script. In the function above, we obviously want the output of `$strBld.ToString()` to be the function's only output but we get the following output instead:

```
PS> LongNumericString

                  Capacity                MaxCapacity                     Length
                  --------                -----------                     ------
                        16                 2147483647                          1
                        16                 2147483647                          2
                        16                 2147483647                          3
```

```
                        16                  2147483647                         4
                        16                  2147483647                         5
                        16                  2147483647                         6
                        16                  2147483647                         7
                        16                  2147483647                         8
                        16                  2147483647                         9
                        16                  2147483647                        10
                        16                  2147483647                        12
                        16                  2147483647                        14
                        16                  2147483647                        16
                        32                  2147483647                        18
                        32                  2147483647                        20
                        32                  2147483647                        22
                        32                  2147483647                        24
                        32                  2147483647                        26
                        32                  2147483647                        28
                        32                  2147483647                        30
012345678910111213141516171819
```

Yikes! That is probably more than what you were expecting. The problem is that the *StringBuilder.Append()* method returns the *StringBuilder* object which allows you to cascade calls to Append. Unfortunately, now our function outputs 20 *StringBuilder* objects and one *System.String* object. It is simple to fix though, just throw away the unwanted output like so:

```
PS> function LongNumericString {
>>     $strBld = new-object System.Text.StringBuilder
>>     for ($i=0; $i -lt 20; $i++) {
>>         [void]$strBld.Append($i)
>>     }
>>     $strBld.ToString()
>> }
>>
PS> LongNumericString
012345678910111213141516171819
```

Other Types of Output That Can't Be Captured

In the previous section we saw one instance of a particular output type - Write-Host - that doesn't contribute to the stdout output stream. In fact, this type of output can't be captured except by the host. The argument to Write-Host's -object parameter is sent directly to the host's console bypassing the stdout output stream. So unlike stderr output that can be captured as shown below, Write-Host output doesn't use streams and therefore can't be redirected.

```
PS> $result = remove-item ThisFilenameDoesntExist 2>&1
PS> $result | foreach {$_.GetType().Fullname}
System.Management.Automation.ErrorRecord
```

Write-Host output can only be captured using the Start-Transcript cmdlet. Start-Transcript logs everything that happens during a PowerShell session except, unfortunately, legacy application output. Keep in mind that Start-Transcript is meant more for session logging than individual script logging. For instance, if you normally invoke

Start-Transcript in your profile to log your PowerShell session, a script that calls Start-Transcript will generate an error because you can't start a nested transcript. You have to stop the previous one first.

Here is the run down on the forms of output that can't be captured except via Start-Transcript:

1. *Direct to Host output* via Write-Host & Out-Host
2. *Debug output* via Write-Debug or -Debug on a cmdlet
3. *Warning output* via Write-Warning
4. *Verbose output* via many cmdlets that output extra information to the host when -Verbose is specified
5. Stdout or stderr from an executable.

That's it. Just remember to keep an eye on what statements and expressions are contributing to the output of your PowerShell functions. Testing is always a good way to verify that you are getting the output you expect.

Item 3: Know What Objects Are Flowing Down the Pipeline

To use Windows PowerShell pipelines effectively, it helps to know what objects are flowing down the pipeline. Sometimes objects get transformed from one type to another. Without the ability to inspect what type is being used at each stage of the pipeline the results you see at the end can be mystifying. For example, the following question came up on the *microsoft.public.windows.powershell* newsgroup:

"Given a set of sub directories in a known directory, I need to CD into each directory and execute a command. "

One approach to solving this is:

```
PS> Get-Item * | Where {$_.PSIsContainer} | Push-Location -passthru |
>>  Foreach {du .; Pop-Location}
```

That worked fine for the *du* utility when specifying the current directory using '.'. However, in the spirit of experimentation I thought I would try specifying the full path. I was a bit surprised when it didn't work:

```
PS> Get-Item * | Where {$_.PSIsContainer} | Push-Location -passthru |
>>  Foreach {du $_.Fullname; Pop-Location}


Du v1.31 - report directory disk usage
Copyright (C) 2005-2006 Mark Russinovich
Sysinternals - www.sysinternals.com


No matching files were found.
...
```

To see what is going on here let's use Get-Member:

```
PS> Get-Item * | Where {$_.PSIsContainer} | Get-Member


   TypeName: System.IO.DirectoryInfo
```

```
Name                       MemberType     Definition
----                       ----------     ----------
Create                     Method         System.Void Create(), System.Void C...
...
```

Get-Member shows *DirectoryInfo* objects flowing out of the "where" stage of the pipeline which is what I expected. Let's look further down the pipeline:

```
PS> Get-Item * | Where {$_.PSIsContainer} | Set-Location -PassThru | Get-Member


   TypeName: System.Management.Automation.PathInfo

Name             MemberType Definition
----             ---------- ----------
Equals           Method     System.Boolean Equals(Object obj)
GetHashCode      Method     System.Int32 GetHashCode()
GetType          Method     System.Type GetType()
ToString         Method     System.String ToString()
Drive            Property   System.Management.Automation.PSDriveInfo Drive {...
Path             Property   System.String Path {get;}
Provider         Property   System.Management.Automation.ProviderInfo Provid...
ProviderPath     Property   System.String ProviderPath {get;}
```

Now Get-Member is showing *PathInfo* objects flowing out of the "Set-Location" stage of the pipeline? I did not expect that. What's going on here? Apparently Set-Location took our *DirectoryInfo* objects and turned them into *PathInfo* objects and passed those down the pipeline honoring the -PassThru parameter. However in this case, Set-Location didn't "pass thru" the original object. It gave us an entirely new object! You will notice that the *PathInfo* object doesn't have a Fullname parameter but it does have several path related parameters. Now which one of those should we use? Let's use the Format-List cmdlet to see all values of the *PathInfo* object output by Set-Location.

```
PS> Get-Item * | Where {$_.PSIsContainer} | Set-Location -PassThru |
>>  Select -First 1 | Format-List *


Drive        :
Provider     : Microsoft.PowerShell.Core\FileSystem
ProviderPath : C:\Bin
Path         : Microsoft.PowerShell.Core\FileSystem::C:\Bin
```

Now that we can see the property values it is pretty obvious that the ProviderPath property is the one to use when passing the path to a legacy executable. It is very doubtful that such an executable would understand how to interpret the Path property. Note that in this example I also used Select -First 1 to pick off the first directory. This is handy if the command outputs a lot of objects. There's no point in waiting for potentially thousands of objects to be processed when all you need is to see the property values for one of them.

One thing to note about Get-Member for this scenario is that it outputs a lot of type member information that is just noise when all you want to know is the type names of the objects. Get-Member also only shows you the type information once for each unique type of object. This gives you no sense of how many objects of the various types are passing down the pipe. This information is easy to access via the GetType() method that is available on all .NET objects e.g.:

```
PS> Get-ChildItem | Foreach {$_.GetType().FullName}
System.IO.DirectoryInfo
System.IO.DirectoryInfo
System.IO.DirectoryInfo
System.IO.DirectoryInfo
System.IO.DirectoryInfo
System.IO.DirectoryInfo
System.IO.FileInfo
System.IO.FileInfo
System.IO.FileInfo
```

GetType() returns a *System.RuntimeType* object that has all sorts of interesting information. The property we are interested in is FullName. If I had used Get-Member instead I would have gotten about 125 lines of text surrounding the two lines indicating the type names. In fact this sort of filter is so handy that it is worth putting in your profile:

```
PS> filter Get-TypeName {if ($_ -eq $null) {'<null>'} else {$_.GetType().Fullname }}
PS> Get-Date | Get-TypeName
System.DateTime
```

The PowerShell Community Extensions provides this filter; however, its implementation is a bit more robust. For instance, there are occasions when it is also important to know that no objects were passed down the pipeline. Our simple Get-TypeName filter isn't so helpful here:

```
PS> @() | Get-TypeName
```

We get no output, which is perhaps a reasonable indication that no objects were output down the pipe. However, with the PSCX implemention of this filter, we wanted to provide a bit more guidance in this situation e.g.:

```
PS> @() | Get-TypeName
WARNING: Get-TypeName did not receive any input. The input may be an empty collection.
You can either prepend the collection expression with the comma operator e.g.
",$collection | gtn" or you can pass the variable or expression to Get-TypeName as an
argument e.g. "gtn $collection".

PS> ,@() | Get-TypeName -full
System.Object[]
```

In summary, when debugging the flow of objects down the pipe be sure to take advantage of Get-Member to show you what properties and methods are available on those objects. Use Format-List * to show you all the property values on those objects. And use our handy little Get-TypeName filter to see the type names of each and every individual object passed down the pipe in the order that the next cmdlet will see them.

Item 4: Output Cardinality - Scalars, Collections and Empty Sets - Oh My!

In Item 2: Understanding Output, we covered a lot of ground with respect to PowerShell output. However, there is a bit more you need to understand to use PowerShell effectively. This item concerns the cardinality of PowerShell output. That is, when does PowerShell output a scalar (single value) versus a collection (multiple values)? And in some cases, there is no output at all which I refer to as an empty set. I use the term collection in a broad manner for various types of collections including arrays.

Working with Scalars

Working with scalars in PowerShell is straight forward. All the examples below generate scalar values:

```
PS> $num = 1
PS> $str = "Hi"
PS> $flt = [Math]::Pi
PS> $proc = (get-process)[0]
PS> $date = Get-Date
```

However you may be dealing with scalars when you think you are working with collections. For instance, when you send a collection down the pipe, PowerShell will automatically "flatten" the collection, meaning that each individual element of the collection is sent down the pipe, one after the other. For example:

```
PS> filter Get-TypeName {$_.GetType().Fullname}
PS> $array = "hi",1,[Math]::Pi,$false
PS> $array | Get-TypeName
System.String
System.Int32
System.Double
System.Boolean
```

In fact, the downstream pipeline stages do not operate on the original collection as a whole. The vast majority of the time this collection flattening behavior within the pipeline is what you want. Otherwise, you would have to write script like this to manually flatten the collection:

```
PS> foreach ($item in $array) {$item} | Get-TypeName
```

Note that this would require us to manually flatten every collection with the insertion of an extra *foreach* statement in the pipe. Since pipelines are typically used to operate on the elements of a sequence and not the sequence as a whole, it is very sensible that PowerShell does this flattening automatically. However, there may be times when you need to defeat the flattening. There's good news and bad news on this topic. First, let's dispense the bad news. Technically you can't defeat this behavior. PowerShell always flattens collections. The good news is that we can work around PowerShell's flattening behavior by creating a new collection that contains just one element - our original collection. PowerShell provides us with a nice shortcut to do just that. For example, this is how I would modify the previous example to send an array intact down the pipe and not each element:

```
PS> ,$array | Get-TypeName
System.Object[]
```

The change is subtle. Notice the comma just before $array? That is the unary comma operator and it instructs PowerShell to wrap the object following it, whatever that object is, in a new array that contains a single element - the original object. PowerShell is still doing its flattening work, we just introduced another collection to get the result that we wanted.

Another feature of PowerShell that is somewhat unique with respect to scalar handling is how the *foreach* statement handles scalars. For example, the following script might surprise some C# developers:

```
PS> $vars = 1
PS> foreach ($var in $vars) { "`$var is $var" }
$var is 1
```

This is because in languages like C#, the variable $vars would have to represent a collection (*IEnumerable*) or you would get a compiler error. This isn't a problem in PowerShell because if $vars is a scalar, PowerShell will treat $vars as if it were a collection containing just that one scalar value. Again, this is a good thing in PowerShell; otherwise, if we wrote code like this:

```
PS> $files = Get-ChildItem *.sys
PS> foreach ($file in $files) { "File is: $file" }
File is: C:\config.sys
```

We would need to modify it to do special handling for the case where Get-ChildItem finds only one .SYS file. Our script code does not have to suffer the "line noise" necessary to do the check between scalar versus collection data shapes. Now the astute reader may ask "What if Get-ChildItem doesn't find any .SYS files?". Hold that thought for a bit.

Working with Collections

Working with collections in PowerShell is also straight forward. All the examples below generate collections:

```
PS> $nums = 1,2,3+7..20
PS> $strs = "Hi", "Mom"
PS> $flts = [Math]::Pi, [Math]::E
PS> $procs = Get-Process
```

Sometimes you may want to treat the result of a command as a collection, even though it may return a single (scalar) value. PowerShell provides a convenient operator to ensure this - the array subexpression operator. Let's look at our Get-ChildItem command again. This time we will force the result to be a collection:

```
PS> $files = @(Get-ChildItem *.sys)
PS> $files.GetType().Fullname
System.Object[]
PS> $files.length
1
```

In this case, only one file was found. It is important for you to know when you are dealing with a scalar versus a collection because both collections and *FileInfo*'s have a Length property. I have seen this trip up more than a few people. Given that the unary comma operator always wraps the original object in a new array, what does the array subexpression operator do when it operates on an array? Let's see:

```
PS> $array = @(1,2,3,4)
PS> $array.rank
1
PS> $array.length
4
```

As we can see, in this case the array subexpression operator has no effect. Again, the astute reader should be asking about the case where Get-ChildItem returns nothing?

Working with Empty Sets

Let's address the issue of a command that doesn't return any output. This is a somewhat tricky area of PowerShell that you should understand in order to avoid script errors. First, let's document a few rules:

1. Valid output can consist of no output i.e. what I've been calling an empty set
2. When assigning output to a variable in PowerShell, $null is used to represent an empty set.
3. The *foreach* statement iterates over a scalar once, even if that scalar happens to be $null.

Seems simple, right? Well, these rules combine in somewhat surprising ways that can cause problems in your scripts. Here is an example:

```
PS> function GetSysFiles { }
PS> foreach ($file in GetSysFiles) { "File: $file" }
PS>
```

GetSysFiles has no output so the *foreach* statement had nothing to iterate over since the invocation of GetSysFiles returned no output. So far, so good but let's try a variation. Assume that our function invocation takes a long argument list which leads us to want to put the function invocation on its own line like so:

```
PS> $files = GetSysFiles SomeReallyLongSetOfArguments
PS> foreach ($file in $files) { "File: $file" }
File:
```

Hmm, now we got output and all we did was introduce an intermediate variable to contain the output of the function. Honestly this violates the *Principle of Least Surprise* in my opinion. Let me explain what is happening.

By using the temp variable we have invoked rule #2 - assigning to a variable results in our empty set getting converted to $null when it is assigned to $files. This seems reasonable so far. Unfortunately our *foreach* statement abides by rule #3 even when the scalar value is $null. In general, PowerShell handles references to $null quite nicely. Notice that our string substitution above in the *foreach* statement didn't error when it encountered the $null. It just didn't print anything for $null. However, .NET framework methods aren't nearly as forgiving:

```
PS> foreach ($file in $files) { "Basename: $($file.Substring(0,$file.Length-4))" }
You cannot call a method on a null-valued expression.
```

```
At line:1 char:16
+ $file.Substring( <<<< 0,$file.Length-4)
Basename:
```

Houston, we've got a problem. That means that you really need to be careful when using *foreach* to iterate over the results of a command where you aren't sure what the cardinality of the results will be and if your script won't tolerate iterating over $null. Note that using the array subexpression operator can help here but it is crucial to use it in the correct place. Again, an issue with the language that should be fixed. For example, the following placement does not work:

```
PS> foreach ($file in @($files)) { "Basename: $($file.Substring(0,$file.Length-4))" }
You cannot call a method on a null-valued expression.
At line:1 char:16
+ $file.Substring( <<<< 0,$file.Length-4)
Basename:
```

Since $files was already set to $null, the array subexpression operator just creates an array with a single element, $null, which *foreach* happily iterates over.

What I recommend is to put the function call entirely within the *foreach* statement if the function call is terse. The *foreach* statement obviously knows what to do when the function has no output. If the function call is lengthy, then I recommend that you do it this way:

```
PS> $files = @(GetSysFiles SomeReallyLongSetOfArguments)
PS> foreach ($file in $files) { "Basename: $($file.Substring(2))" }
PS>
```

When you apply the array subexpression operator directly to a function that has no output, you will get an empty array and not an array with a $null in it.

If you would like your functions to be able to return empty arrays, use the comma operator as shown below to ensure that the results you return are in array form.

```
function ReturnArrayAlways {
    $result = @()
    # Do something here that may add 0, 1 or more elements to array $result
    # $result = 1
    # or
    # $result = 1,2
    ,$result
}
```

Item 5: Use the Objects, Luke. Use the Objects!

Using Windows PowerShell requires a shift in your mental model with respect to how a shell deals with information. In most shells like cmd.exe, Korn shell, C shell, Bash, etc you deal primarily with information in text form. For instance the output of *ls* or *ps* is text which is then cut, prodded and parsed to coax out the required pieces of information. As it turns out, PowerShell provides very handy text manipulation functions like:

- -like
- -notlike
- -match
- -notmatch
- -replace
- -eq
- -ne
- -ceq (case-sensitive)
- -cne (case-sensitive)

Note that by default, PowerShell treats all text (actually *System.String* objects) in a case-insensitive manner when performing comparisons or regular expression search and replace operations. Because of these handy string manipulation features, it is very easy to "fall back" into the old way of string cutting, parsing and string comparisons. Sometimes this is unavoidable even in PowerShell but many times you can use the object provided to you. The benefits are often:

- Easier to understand code
- Easier to avoid mistakes (changing output formats, bad regexes, incorrect comparison technique)
- Better performance

Let's look at an example. The following issue came up in the *public.microsoft.windows.powershell* newsgroup.

"How do you test the output of dir a.k.a. Get-ChildItem to filter out directories leaving only the files to be operated on further down the pipeline?"

Here's an approach to this problem that I think of as "falling back" into the old ways:

```
PS> Get-ChildItem | Where {$_.mode -ne "d"}
```

First let me point out that this command doesn't work but more importantly it relies on string comparisons to determine whether or not an item passing down the pipeline is a folder. If you are bent on doing the filtering the "old way" then the following will work however it is easy to get the string comparison wrong if you aren't careful:

```
PS> Get-ChildItem | Where {$_.mode -notlike "d*"}
```

There is a better approach for this type of problem - the PowerShell way. PowerShell decorates every item that is output by the Get-ChildItem and the other *-Item cmdlets with additional properties. This is even independent of which provider is being used: file system, registry, function, etc. We can see those extra properties, all of which are prefixed with PS, by using our old friend Get-Member like so:

```
PS Function:\> New-Item -type function "foo" -value {} | Get-Member


   TypeName: System.Management.Automation.FunctionInfo

Name            MemberType   Definition
----            ----------   ----------
Equals          Method       System.Boolean Equals(Object obj)
GetHashCode     Method       System.Int32 GetHashCode()
GetType         Method       System.Type GetType()
ToString        Method       System.String ToString()
PSDrive         NoteProperty System.Management.Automation.PSDriveInfo ...
PSIsContainer   NoteProperty System.Boolean PSIsContainer=False
PSPath          NoteProperty System.String PSPath=Microsoft.PowerShell...
PSProvider      NoteProperty System.Management.Automation.ProviderInfo...
CommandType     Property     System.Management.Automation.CommandTypes...
Definition      Property     System.String Definition {get;}
Name            Property     System.String Name {get;}
Options         Property     System.Management.Automation.ScopedItemOp...
ScriptBlock     Property     System.Management.Automation.ScriptBlock ...
```

One of those extra properties is PSIsContainer and this property tells us that the object is a container object. For the registry, this means RegistryKey and for the file system it means directory (*DirectoryInfo* object). So this problem can be solved more directly like so:

```
PS> Get-ChildItem | Where {!$_.PSIsContainer}
```

That is a bit less to type and is much less error prone. However what about this performance claim? OK let's try both of these approaches (I'll also throw in the regex-based -notmatch) and measure their performance:

```
PS> $oldWay1 = 1..20 | Measure-Command {Get-ChildItem | Where {$_.mode -notlike "d*"}}
PS> $oldWay2 = 1..20 | Measure-Command {Get-ChildItem | Where {$_.mode -notmatch "d"}}
PS> $poshWay = 1..20 | Measure-Command {Get-ChildItem | Where {!$_.PSIsContainer}}
```

Here are the results:

```
PS> $oldWay1 | Measure-Object TotalSeconds -ave


Count    : 1
Average  : 169.2571743
Sum      :
Maximum  :
Minimum  :
Property : TotalSeconds


PS> $oldWay2 | Measure-Object TotalSeconds -ave
```

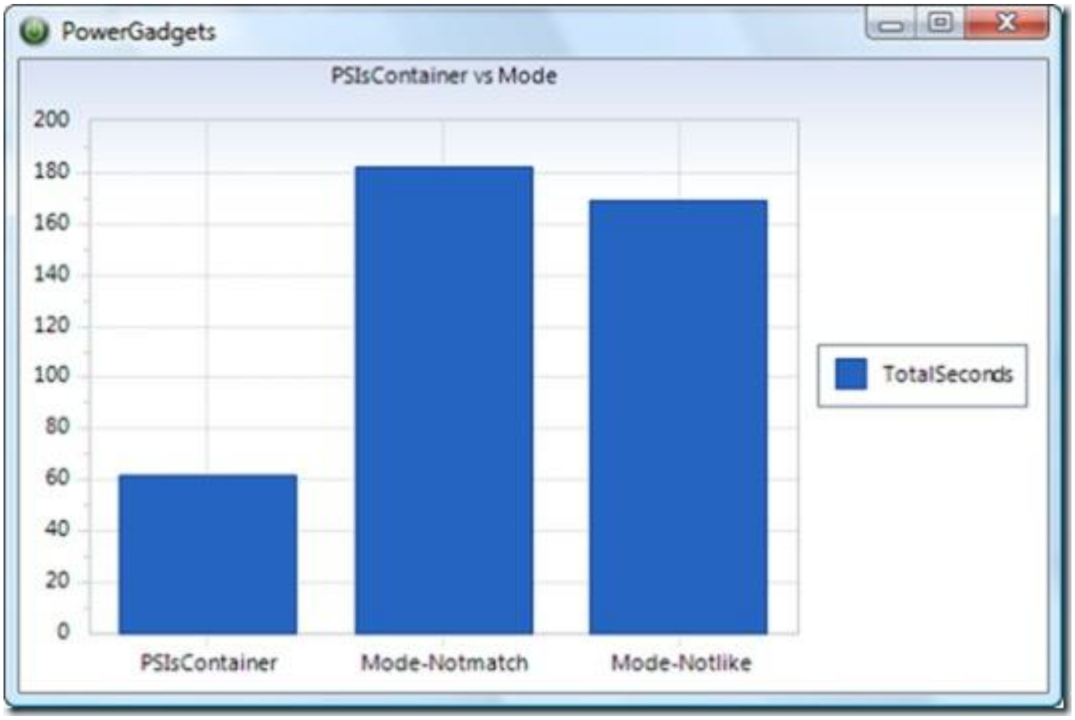
```
Count    : 1
Average  : 181.929144
Sum      :
Maximum  :
Minimum  :
Property : TotalSeconds

PS> $poshWay | Measure-Object TotalSeconds -ave


Count    : 1
Average  : 61.5349126
Sum      :
Maximum  :
Minimum  :
Property : TotalSeconds
```

So doing a little math, in PowerShell of course, we get:

```
PS> "{0:P0}" -f ((169.26 – 61.53) / 61.53)
175 %
```

Yikes! The string comparison approach using the Mode property is over 175% slower than using the PSIsContainer property. With SoftwareFX's PowerGadgets we can see this:

```
PS> $data = @{
>>     'Mode-Notlike'  = $oldWay1.TotalSeconds
>>     'Mode-Notmatch' = $oldWay2.TotalSeconds
>>     PSIsContainer   = $poshWay.TotalSeconds
>>  }
>>
PS> $data.Keys | Select @{n='Method';e={$_}},@{n='TotalSeconds';e={$data[$_]}} |
>>  Out-Chart -Title "PSIsContainer vs Mode"
>>
```



PowerGadgets is pretty sweet. I use it when presenting version control usage reports to project managers. This is off topic but I have one chart that displays the check-in activity per day. It is interesting to see the spike in source code check-ins just prior to the conclusion of each milestone. :-)

The PowerShell console output gives you the illusion that you are only dealing with text but there are .NET objects behind all that text output! You are often dealing with objects richer in information than *System.String* and many times those objects have just the information you are looking for in the form of a property. You can then extract that information without resorting to text parsing. For an additional example of operating on object properties instead of textual output, check out my post on *Sorting IPAddresses the PowerShell Way* (http://tinyurl.com/PsSortIP).

Item 6: Know Your Output Formatters

I have mentioned previously that Windows PowerShell serves up .NET objects for most everything. Get-ChildItem outputs a sequence of *System.IO.FileInfo* and *System.IO.DirectoryInfo* objects output. Get-Date outputs a *System.DateTime* object. Get-Process outputs *System.Diagnostics.Process* objects and Get-Content outputs *System.String* objects (or arrays of them based on how -ReadCount is set). You get the idea. PowerShell's currency is .NET objects. This isn't always obvious because of the way that PowerShell renders these .NET objects to text for display on the host's console. Let's imagine for a moment that we had to figure out how to solve this problem ourselves.

Our first approach might be to rely on the *ToString()* method that is available on every .NET object. That would work fine for some .NET objects e.g.:

```
PS> (Get-Date).ToString()
9/3/2007 10:21:23 PM
```

But not so well for others:

```
PS> (Get-Process)[0].ToString()
System.Diagnostics.Process (audiodg)
```

Hmm, that is certainly less than satisfying. Let's look at how the PowerShell team solved this problem. They invented the notion of "views" for the common .NET types which could be tabular, list, wide or custom. For .NET types PowerShell knows about it will declare a default view so you get decent text output without having to specify a formatting cmdlet. For .NET types that PowerShell doesn't know about it will choose a formatterIf you don't specify a formatting cmdlet then PowerShell will choose a formatter based on the default view for a .NET type which could be tabular, list, wide or custom.

Quick definition break: types versus objects. The *System.DateTime* class is a .NET type, there is only one of these. The Get-Date cmdlet outputs an object which is an instance of the *System.DateTime* type. There can be many *DateTime* objects based off the one definition of *System.DateTime*. PowerShell defines a view for the type that gets applied to all instances (objects) of that type.

What if PowerShell doesn't define a view for a .NET type? This is a certainty because the possible set of .NET types is infinite. I could create one right now called Plan9FromOuterSpace, compile it into a .NET assembly and load it into PowerShell. How's PowerShell going to deal with the type it isn't familiar with? Let's see:

```
@'
public class Plan9FromOuterSpace {
    public string Director = "Ed Wood";
    public string Genre = "Science Fiction B Movie";
    public int NumStars = 0;
}
'@ > C:\temp\Plan9.cs

PS> csc /t:library Plan9.cs
PS> [System.Reflection.Assembly]::LoadFrom('c:\temp\Plan9.dll')
PS> New-Object Plan9FromOuterSpace

Director                Genre                                       NumStars
--------                -----                                       --------
Ed Wood                 Science Fiction B Movie                            0
```

Through experimentation it seems that for up to four public properties, PowerShell will use a tabular view. If the object has five or more public properties then PowerShell falls back to a list view.

There can be multiple views defined for a single .NET type. These views are defined in XML format files in the PowerShell install directory:

```
PS> Get-ChildItem $PSHOME\*format*

    Directory: Microsoft.PowerShell.Core\FileSystem::C:\Windows\System32\
    WindowsPowerShell\v1.0

Mode                LastWriteTime     Length Name
----                -------------     ------ ----
-a---          1/24/2007  11:23 PM     22120 Certificate.format.ps1xml
-a---          1/24/2007  11:23 PM     60703 DotNetTypes.format.ps1xml
-a---          1/24/2007  11:23 PM     19730 FileSystem.format.ps1xml
-a---          1/24/2007  11:23 PM    250197 Help.format.ps1xml
-a---          1/24/2007  11:23 PM     65283 PowerShellCore.format.ps1xml
-a---          1/24/2007  11:23 PM     13394 PowerShellTrace.format.ps1xml
-a---          1/24/2007  11:23 PM     13540 Registry.format.ps1xml
```

The contents of these files look something like this:

```
<View>
  <Name>process</Name>
  <ViewSelectedBy>
    <TypeName>System.Diagnostics.Process</TypeName>
    <TypeName>Deserialized.System.Diagnostics.Process</TypeName>
  </ViewSelectedBy>
  <TableControl>
    <TableHeaders>
      <TableColumnHeader>
        <Label>Handles</Label>
        <Width>7</Width><Alignment>right</Alignment>
      </TableColumnHeader>
      <TableColumnHeader>
        <Label>NPM(K)</Label>
        <Width>7</Width><Alignment>right</Alignment>
      </TableColumnHeader>
      <TableColumnHeader>
        <Label>PM(K)</Label>
        <Width>8</Width><Alignment>right</Alignment>
      </TableColumnHeader>
      <TableColumnHeader>
        <Label>WS(K)</Label>
        <Width>10</Width><Alignment>right</Alignment>
      </TableColumnHeader>
      <TableColumnHeader>
        <Label>VM(M)</Label>
        <Width>5</Width><Alignment>right</Alignment>
      </TableColumnHeader>
      <TableColumnHeader>
        <Label>CPU(s)</Label>
        <Width>8</Width><Alignment>right</Alignment>
      </TableColumnHeader>
      <TableColumnHeader>
        <Width>6</Width><Alignment>right</Alignment>
      </TableColumnHeader>
      <TableColumnHeader />
    </TableHeaders>
    <TableRowEntries>
```

```
      <TableRowEntry>
        <TableColumnItems>
          <TableColumnItem>
            <PropertyName>HandleCount</PropertyName>
          </TableColumnItem>
          <TableColumnItem>
            <ScriptBlock>[int]($_.NPM / 1024)</ScriptBlock>
          </TableColumnItem>
          <TableColumnItem>
            <ScriptBlock>[int]($_.PM / 1024)</ScriptBlock>
          </TableColumnItem>
          <TableColumnItem>
            <ScriptBlock>[int]($_.WS / 1024)</ScriptBlock>
          </TableColumnItem>
          <TableColumnItem>
            <ScriptBlock>[int]($_.VM / 1048576)</ScriptBlock>
          </TableColumnItem>
          <TableColumnItem>
            <ScriptBlock>
              if ($_.CPU -ne $()) {
                  $_.CPU.ToString("N")
              }
            </ScriptBlock>
          </TableColumnItem>
          <TableColumnItem>
            <PropertyName>Id</PropertyName>
          </TableColumnItem>
          <TableColumnItem>
            <PropertyName>ProcessName</PropertyName>
          </TableColumnItem>
        </TableColumnItems>
      </TableRowEntry>
    </TableRowEntries>
  </TableControl>
</View>
```

The XML definition above is of the "table view" for the Process type. It defines the column attributes of the view as well as the data that goes into each column, in some cases massaging the data into a more easily consumable value (KB vs. bytes or MB vs. bytes). Here is the "wide view" definition for the Process type:

```
<View>
  <Name>process</Name>
  <ViewSelectedBy>
    <TypeName>System.Diagnostics.Process</TypeName>
  </ViewSelectedBy>
  <WideControl>
    <WideEntries>
      <WideEntry>
        <WideItem>
          <PropertyName>ProcessName</PropertyName>
        </WideItem>
      </WideEntry>
    </WideEntries>
  </WideControl>
</View>
```

In this "wide view" the only property that PowerShell will display is the ProcessName. In searching the DotNetTypes.format.ps1xml, we can find more definitions. The following StartTime "named view" isn't invoked by default. You have to specify it by name to the Format-Table cmdlet:

```
<View>
  <Name>StartTime</Name>
  <ViewSelectedBy>
    <TypeName>System.Diagnostics.Process</TypeName>
  </ViewSelectedBy>
  <GroupBy>
    <ScriptBlock>$_.StartTime.ToShortDateString()</ScriptBlock>
    <Label>StartTime.ToShortDateString()</Label>
  </GroupBy>
  <TableControl>
    <TableHeaders>
      <TableColumnHeader>
        <Width>20</Width>
      </TableColumnHeader>
      <TableColumnHeader>
        <Width>10</Width>
        <Alignment>right</Alignment>
      </TableColumnHeader>
      <TableColumnHeader>
        <Width>13</Width>
        <Alignment>right</Alignment>
      </TableColumnHeader>
      <TableColumnHeader>
        <Width>12</Width>
        <Alignment>right</Alignment>
      </TableColumnHeader>
    </TableHeaders>
    <TableRowEntries>
      <TableRowEntry>
        <TableColumnItems>
          <TableColumnItem>
            <PropertyName>ProcessName</PropertyName>
          </TableColumnItem>
          <TableColumnItem>
            <PropertyName>Id</PropertyName>
          </TableColumnItem>
          <TableColumnItem>
            <PropertyName>HandleCount</PropertyName>
          </TableColumnItem>
          <TableColumnItem>
            <PropertyName>WorkingSet</PropertyName>
          </TableColumnItem>
        </TableColumnItems>
      </TableRowEntry>
    </TableRowEntries>
  </TableControl>
</View>
```

Why I am showing you all this? I think it is important to understand the magic behind how a .NET object, a binary entity, gets rendered into text on your host's console. With this knowledge, you should never forget that you are dealing with .NET objects first and foremost.

You may also be wondering if there is an easier way to figure out what views are available for any particular .NET type. There is if you have the PowerShell Community Extensions installed. PSCX provides a handy script written by Joris van Lier called Get-ViewDefinition and you can use it like so:

```
PS> Get-Viewdefinition System.Diagnostics.Process


Name       : process
Path       : C:\Windows\System32\WindowsPowerShell\v1.0\DotNetTypes.format.ps1xml
TypeName   : System.Diagnostics.Process
SelectedBy : {System.Diagnostics.Process, Deserialized.System.Diagnostics.Process}
GroupBy    :
Style      : Table

Name       : Priority
Path       : C:\Windows\System32\WindowsPowerShell\v1.0\DotNetTypes.format.ps1xml
TypeName   : System.Diagnostics.Process
SelectedBy : System.Diagnostics.Process
GroupBy    : PriorityClass
Style      : Table

Name       : StartTime
Path       : C:\Windows\System32\WindowsPowerShell\v1.0\DotNetTypes.format.ps1xml
TypeName   : System.Diagnostics.Process
SelectedBy : System.Diagnostics.Process
GroupBy    :
Style      : Table

Name       : process
Path       : C:\Windows\System32\WindowsPowerShell\v1.0\DotNetTypes.format.ps1xml
TypeName   : System.Diagnostics.Process
SelectedBy : System.Diagnostics.Process
GroupBy    :
Style      : Wide
```

From this output you can see that there are quite a few views that you might not have been aware of related to the *System.Diagnostics.Process* .NET type that Get-Process outputs. Let's check out these alternate views:

```
PS> Get-Process | Format-Wide


audiodg                              csrss
csrss                                devenv
dexplore                             DPAgnt
DpHost                               dwm
EDICT                                ehmsas
ehtray                               explorer
FlashUtil9d                          Idle
ieuser                               iexplore
iexplore                             iexplore
...
```

```
PS> Get-Process | Format-Table -View Priority

ProcessName                  Id   HandleCount   WorkingSet
-----------                  --   -----------   ----------
audiodg                    1276           125      9592832
csrss                       548           775      3440640
csrss                       604           831     14360576
devenv                     2632           974     93655040

   PriorityClass: Normal

ProcessName                  Id   HandleCount   WorkingSet
-----------                  --   -----------   ----------
dexplore                   4324           401      4214784
DPAgnt                     3300           133      2674688
DpHost                      352           207     10928128

   PriorityClass: High

ProcessName                  Id   HandleCount   WorkingSet
-----------                  --   -----------   ----------
dwm                        4072           235     86724608
...


PS> Get-Process | Format-Table -View StartTime

ProcessName                  Id   HandleCount   WorkingSet
-----------                  --   -----------   ----------
audiodg                    1276           120      9572352
csrss                       548           757      3432448
csrss                       604           834     14360576
devenv                     2632           974     93655040

   StartTime.ToShortDateString(): 8/31/2007

ProcessName                  Id   HandleCount   WorkingSet
-----------                  --   -----------   ----------
dexplore                   4324           401      4214784

   StartTime.ToShortDateString(): 8/29/2007
...
```

What if you have forgotten what formatters are available to you in PowerShell? Don't forget that you can use Get-Command like so:

```
PS> Get-Command Format-*

CommandType     Name                            Definition
-----------     ----                            ----------
Cmdlet          Format-Custom                   Format-Custom [[-Property...
Cmdlet          Format-List                     Format-List [[-Property] ...
Cmdlet          Format-Table                    Format-Table [[-Property]...
Cmdlet          Format-Wide                     Format-Wide [[-Property] ...
```

You are probably already pretty familiar with Format-Table. It presents data in tabular format. This is the default format for many views including the default view for *System.Diagnostics.Process*. Format-Wide is also pretty straight-forward. PowerShell displays a single property defined by PowerShell (i.e. the most interesting) in multiple columns. Format-Custom is interesting but probably not a formatter that you will use that often - it will be implicitly invoked for those .NET types that have custom views like *System.DateTime*:

```xml
<View>
  <Name>DateTime</Name>
  <ViewSelectedBy>
    <TypeName>System.DateTime</TypeName>
  </ViewSelectedBy>
  <CustomControl>
    <CustomEntries>
      <CustomEntry>
        <CustomItem>
          <ExpressionBinding>
            <PropertyName>DateTime</PropertyName>
          </ExpressionBinding>
        </CustomItem>
      </CustomEntry>
    </CustomEntries>
  </CustomControl>
</View>
```

DateTime is a ScriptProperty that PowerShell has defined like so:

```
PS> Get-Date | Get-Member -Name DateTime

   TypeName: System.DateTime

Name     MemberType     Definition
----     ----------     ----------
DateTime ScriptProperty System.Object DateTime {get=if ($this.DisplayHint -i...
```

This brings me to my favorite formatter that I use when I'm spelunking PowerShell output. Notice that the Definition column above is truncated. Often when I want to see everything I will use the Format-List cmdlet. This formatter outputs the various property values on individual lines so that data is rarely truncated e.g.:

```
PS> Get-Date | Get-Member -Name DateTime | Format-List


TypeName   : System.DateTime
Name       : DateTime
MemberType : ScriptProperty
Definition : System.Object DateTime {get=if ($this.DisplayHint -ieq  "Date")
                                 {
                                     "{0}" -f $this.ToLongDateString()
                                 }
                                 elseif ($this.DisplayHint -ieq "Time")
                                 {
                                     "{0}" -f  $this.ToLongTimeString()
                                 }
                                 else
                                 {
                                     "{0} {1}" -f $this.ToLongDateString(),
                                                  $this.ToLongTimeString()
                                 };}
```

Now we can see the entire definition of the DateTime ScriptProperty. Note: PowerShell often defines an abbreviated set of these property values to display by default with the Format-List cmdlet. It doesn't want you to be overwhelmed with information. However, when you're spelunking you typically want to see all the gory details. All you have to do to get all the property values listed is execute "format-list *". Check out the default list format for a Process object:

```
PS> (Get-Process)[0] | Format-List


Id      : 1284
Handles : 103
CPU     :
Name    : audiodg
```

versus what you get when you ask Format-List to give you everything:

```
PS> (Get-Process)[0] | Format-List *


__NounName                 : Process
Name                       : audiodg
Handles                    : 99
VM                         : 47075328
WS                         : 9027584
PM                         : 11141120
NPM                        : 3360
Path                       :
Company                    :
CPU                        :
FileVersion                :
ProductVersion             :
Description                :
Product                    :
Id                         : 1284
```

```
PriorityClass              :
HandleCount                : 99
WorkingSet                 : 9027584
PagedMemorySize            : 11141120
PrivateMemorySize          : 11141120
VirtualMemorySize          : 47075328
...
```

See what I mean? Look at how much information you would have missed if you forgot to specify that you want to see all properties via the asterisk.

Item 7: Understanding PowerShell Parsing Modes

The way PowerShell parses commands can be surprising especially to those that are used to shells with more simplistic parsing like CMD.EXE. Parsing in PowerShell is a bit different because PowerShell needs to work well as both an interactive command line shell **and** a scripting language. This need is driven by use cases such as:

1. Allow execution of commands and programs with arguments at the command line. Consequence: arguments (filenames, paths) should not require quotes unless there is a space in the argument's value.
2. Allow scripts to contain expressions as found in most other programming/script languages. Consequence: PowerShell script should be able to evaluate expressions like *2 + 2* and *$date.Second* as well as specify a string using quotes e.g. "del -r * is being executed".
3. Take code written interactively at the command line and paste it into a script for execution again at some point in the future. Consequence: These two worlds - interactive and script - need to coexist peacefully.

Part and parcel with providing a powerful scripting language is to support more types than just the string type. In fact, PowerShell supports most .NET types including *String*, *Int8*, *Int16*, *Int32*, *Decimal*, *Single*, *Double*, *Boolean*, *Array*, *ArrayList*, *StringBuilder* among many other .NET types. That's very nice you say but what's this got to do with parsing modes? Think about this. How would you expect a language to represent a string literal? Well most folks would probably expect this representation: "Hello World"

And in fact, that is recognized by PowerShell as a string e.g.:

```
PS> "Hello World".GetType().Name
String
PS> "Hello World"
Hello World
```

And if you type a string at the prompt and hit the *Enter* key, PowerShell, being a very nice REPL (Read-eval-print-loop) environment, echoes the string back to the console as shown above. However what if I had to specify command arguments using quotes as shown below?

```
PS> del "foo.txt", "bar.txt", "baz.txt"
```

That would immediately "feel" different than any other command line shell out there. Even worse, typing all those quotes would get annoying really fast. My guess is that the PowerShell team, pretty early on, decided that they were going to need two different parse modes. First they would need to parse like a traditional shell where strings (filenames, directory names, process names, etc) do not need to be quoted. Second they would need to be able to parse like a traditional language where strings are quoted and expressions feel like those you would find in a programming language. In PowerShell, the former is called Command parsing mode and the latter is called Expression parsing mode. It is important to understand which mode you are in and more importantly, how to switch between them.

Let's look at an example. Obviously we would prefer to type the following to delete files:

```
PS> del foo.txt, bar.txt, baz.txt
```

That's better. No quotes required on the filenames. PowerShell treats these filenames as strings even without the quotes in command parsing mode. But what happens if my path has a space in it? You would naturally try:

```
PS> del 'C:\Documents and Settings\Keith\_lesshst'
```

And that works as you would expect. Now what if I want to execute a program with a space in its path:

```
PS> 'C:\Program Files\Windows NT\Accessories\wordpad.exe'
C:\Program Files\Windows NT\Accessories\wordpad.exe
```

That didn't work because as far as PowerShell is concerned we gave it a string, so it just echoes it back to the screen. It did this because it parsed this line in expression mode. We need to tell PowerShell to parse the line in command mode. To do that we use the call operator '`&`' like so:

```
PS> & 'C:\Program Files\Windows NT\Accessories\wordpad.exe'
```

Tip: Help prevent repetitive stress injuries to your wrists and use tab (and shift+tab) completion for auto-completing the parts of a path. If the resulting path contains a space PowerShell will insert the call operator for you as well as surround the path with quotes.

What's going on with this example is that PowerShell looks at the first non-whitespace character of a line to determine which mode to start parsing in. If it sees one of the characters below then PowerShell parses in Command mode:

```
[_aA-zZ]
&
.
\
```

One exception to this rule happens when the line starts with a name that corresponds to a PowerShell language keyword like *if*, *do*, *while*, *foreach*, etc. In this case, PowerShell uses expression parsing mode and expects you to provide the rest of the syntax associated with that keyword. The benefits of Command mode are:

- Strings do not need to be quoted unless there are spaces in the string.
- Numbers are parsed as numbers and all other arguments are treated as strings except those that start with the characters: `@`, `$`, `(`, `'` or `"`. Numbers are interpreted as either *Int32*, *Int64*, *Double* or *Decimal* depending on how the number is decorated and the range required to hold the number e.g. 12, 30GB, 1E-3, 100.01d.

So why do we need expression parsing mode? Well as I mentioned before it sure would be nice to be able to evaluate expressions like this:

```
PS> 64-2
62
```

It isn't a stretch to see how some shells might interpret this example as trying to invoke a command named '64-2'. So how does PowerShell determine if the line should be parsed in expression mode? If the line starts with a number [0-9] or one of these characters: `@`, `$`, `(`, `'` or `"` the line is evaluated in expression mode. The benefits of expression mode are:

- It is possible to disambiguate commands from strings e.g. `del -recurse *` is a command whereas "del -recurse *" is just a string.
- Arithmetic and comparison expressions are straight forward to specify e.g. 64-2 (62) and `$array.count -gt 100`. In command mode, -gt would be interpreted as a parameter if in fact the previous token corresponded to a valid command.

One consequence of the rules for expression parsing mode is that if you want to execute an EXE or script whose name starts with a number you have to quote the name and use the call operator e.g.:

```
PS> & '64E1'
```

If you were to attempt to execute 64E1 without using the call operator, PowerShell can't tell if you want to interpret that as the number 64E1 (640) or execute an exe named 64E1.exe or a script named 64E1.ps1. It is up to you to make sure you have placed PowerShell in the correct parsing mode to get the behavior you want which in this case means putting PowerShell into command parsing mode by using the call operator. Note: I have observed that if you specify the full command name e.g. 64E1.ps1 or 64E1.exe, it isn't necessary to quote the command.

What if you want to mix and match parsing modes on the same line? Easy. Just use either a grouping expression `()`, a subexpression `$()` or an array subexpression `@()`. This will cause the parser to re-evaluate the parsing mode based on the first non-whitespace character inside the parenthesis.

What's the difference between grouping expressions (), subexpressions $() and array subexpressions @()? A grouping expression can contain just a simple expression or single pipeline. A subexpression can contain multiple semicolon separated statements. The output of each statement contributes to the output of the subexpression which can be nothing, a scalar or a collection. An array subexpression behaves just like a subexpression except that it guarantees that the output will be an array. The two cases where this makes a difference are 1) when there is no output at all an array subexpression will produce an empty array and 2) when the result is a scalar value it will produce a single element array containing the scalar value. If the output is already an array then the use of an array subexpession will have no effect on the output i.e. it will not wrap the array inside of another array.

In the following example I have embedded a command "Get-ChildItem C:\Windows" into a line that started out parsing in expression mode. When it encounters the grouping expression (Get-ChildItem C:\Windows), it begins parsing mode re-evaluation, finds the character `'g'` and kicks into command mode parsing for the remainder of the text inside the grouping expression. Note that ".Length" is parsed using expression mode because it is outside the grouping expression, so PowerShell reverts back to the previous parsing mode. ".Length" instructs PowerShell to get the Length property of the object output by the grouping expression. In this case, it is an array of FileInfo and DirectoryInfo objects. The Length property tells us how many items are in that array.

```
PS> 10 + (Get-ChildItem C:\Windows).Length
115
```

We can do the opposite. That is, put expressions in lines that started out parsing in command mode. In the example below we use an expression to calculate the number of objects to select from the sequence of objects.

```
PS> Get-Process | Select -first (1.5 * 2)

Handles  NPM(K)    PM(K)      WS(K) VM(M)   CPU(s)     Id ProcessName
-------  ------    -----      ----- -----   ------     -- -----------
    120       4    11860       9508    46            1320 audiodg
    778       6     1772       3516    88             560 csrss
    922      14     5288      13696   163             620 csrss
```

Using the ability to start new parsing modes, we can nest commands within commands. This is a powerful feature and one I recommend mastering. In the example below PowerShell is happily parsing the command line in command mode when it encounters '@(' i.e. the start of an array subexpression. This causes PowerShell to re-evaluate the parsing mode but in this case it finds a nested command. The nested command grabs the new filename from the first line of the file to be renamed. I used the array subexpression syntax in this case because it guarantees that we will get an array of lines even if there is just one line. If you use a grouping expression instead and the file happens to contain only a single line then PowerShell will interpret the [0] to be "get me the first character in the string" which is `"f"` in the example below.

```
PS> Get-ChildItem [a-z].txt | Foreach{Rename-Item $_ -NewName @(Get-Content $_)[0] -WhatIf}
What if: Performing operation "Rename File" on Target "Item: C:\a.txt Destination:
C:\file_a.txt".
What if: Performing operation "Rename File" on Target "Item: C:\b.txt Destination:
C:\file_b.txt".
```

There is one final subtlety that I would like to point out and that is the difference between using the call operator `&` to invoke commands and "dotting" commands. Consider invoking a simple script that sets the variable `$foo = 'PowerShell Rocks!'`. Let's execute this script using the call operator and observe the impact on the global session:

```
PS> $foo
PS> & .\script.ps1
PS> $foo
```

Note that using the call operator invokes the command in a child scope that gets thrown away when the command (script, function, etc) exits. That is, the script didn't impact the value of `$foo` in the global scope. Now let's try this again by dotting the script:

```
PS> $foo
PS> . C:\Users\Keith\script.ps1
PS> $foo
PowerShell Rocks!
```

When dotting a script, the script executes in the current scope. As a result, the variable `$foo` in script.ps1 effectively becomes a reference to the global $foo when the script is dotted from the command line resulting in changing the global `$foo` variable's value. This shouldn't be too surprising since "dot sourcing", as it's also known, is common in other shells. Note that these rules also apply to function invocation. However for external EXEs it doesn't matter whether you dot source or use the call operator since EXEs execute in a separate process and can't impact the current scope.

Here's a handy reference to help you remember the rules for how PowerShell determines the parsing mode.

First non-whitepace character	Parsing mode
`[_aA-zZ], &, . or \`	Command
`[0-9], ', ", $, (, @ and any other character that doesn't start command parsing mode`	Expression

Once you learn the subtleties of these two parsing modes you will be able to quickly get past those initial surprises like figuring out how to execute EXEs with paths that contain spaces.

Item 8: Understanding ByPropertyName Pipeline Bound Parameters

We all generally like to solve a problem in an efficient way. In PowerShell that usually culminates in a one-liner. For pedagogical purposes I find it much better to expand these terse, almost *Obfuscated C* style, commands into multiple lines. However there is no denying that when you want to bang out something quick at the console, given PowerShell's current line editing features, a one-liner helps stave off repetitive stress injuries. It's not PowerShell's fault. They're just using the antiquated console subsystem in Windows that hasn't changed much since NT shipped in 1993.

One trick to less typing is to take advantage of pipeline bound parameters. Quite often I see folks write a command like:

```
PS> Get-ChildItem . *.cs -r | Foreach { Get-Content $_.fullname } | ...
```

That works but the use of the *Foreach-Object* cmdlet is technically unnecessary. Many PowerShell cmdlets bind their "primary" parameter to the pipeline. This is indicated in the help file for Get-Content as shown below:

```
-path <string[]>
    Specifies the path to an item. Get-Content retrieves the content of the item. Wildcards
    are permitted. The parameter name ("-Path" or "-FilePath") is optional.

    Required?                    true
    Position?                    1
    Default value                N/A - The path must be specified
    Accept pipeline input?       true (ByPropertyName)
    Accept wildcard characters?  true

<snip>

-literalPath <string[]>
    Specifies the path to an item. 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
```

Note: you have to specify the –Full parameter to Get-Help to get this level of detail on a cmdlet paremeters. There are actually four parameters on *Get-Content* that accept pipeline input *ByPropertyName* only two of which are shown above. The other two are ReadCount and TotalCount. The qualifier *ByProperyName* simply means that if the incoming object has a property of that name it is available to be "bound" as input to that parameter. That is, if a type match can be found or coerced.

For instance, we could simplify the command above by eliminating the *Foreach-Object* cmdlet altogether:

```
PS> Get-ChildItem . *.cs -r | Get-Content | ...
```

While it is intuitive that Get-Content should be able to handle the *System.IO.FileInfo* objects that Get-ChildItem outputs, it isn't obvious based on the *ByPropertyName* rule I just mentioned. The reason it isn't obvious is the *FileInfo* objects output by Get-ChildItem do not have either a Path property or a *LiteralPath* property even accounting for the extended properties like *PSPath*. So how does Get-Content determine the path of a file in this pipeline scenario? There are at least two ways to find this out. The first is the easier approach. It uses a PowerShell cmdlet called Trace-Command that shows you how PowerShell binds parameters. The second approach involves spelunking in the PowerShell assemblies using Red Gate's .NET Reflector. Let's tackle this problem initially using Trace-Command.

Trace-Command is a built-in tracing facility that shows a lot of the inner workings of PowerShell. I will warn you that it tends to be prolific with its output. One particularly useful area you can trace is parameter binding. Here's how we would do this for the command above:

```
PS> Trace-Command -Name ParameterBinding -PSHost -Expression {
    Get-ChildItem log.txt | Get-Content }
```

This outputs a lot of text and unfortunately it is "Debug" stream text that isn't easily searchable or redirectable to a file. Oh well. The interesting output from this command is:

```
     BIND PIPELINE object to parameters: [Get-Content]
         PIPELINE object TYPE = [System.IO.FileInfo]
         RESTORING pipeline parameter's original values
         Parameter [ReadCount] PIPELINE INPUT ValueFromPipelineByPropertyName NO COERCION
         Parameter [TotalCount] PIPELINE INPUT ValueFromPipelineByPropertyName NO COERCION
         Parameter [Path] PIPELINE INPUT ValueFromPipelineByPropertyName NO COERCION
         Parameter [Credential] PIPELINE INPUT ValueFromPipelineByPropertyName NO COERCION
         Parameter [ReadCount] PIPELINE INPUT ValueFromPipelineByPropertyName NO COERCION
         Parameter [TotalCount] PIPELINE INPUT ValueFromPipelineByPropertyName NO COERCION
         Parameter [LiteralPath] PIPELINE INPUT ValueFromPipelineByPropertyName  NO COERCION
         BIND arg [Microsoft.PowerShell.Core\FileSystem::C:\Users\Keith\log.txt] to parameter
[LiteralPath]
```

This output has been simplified a bit by eliminating extraneous output. I also changed the initial command to output just a single *FileInfo* object to further reduce the amount of output. The information we get from Trace-Command shows us that PowerShell tries to bind the *FileInfo* object to the Get-Content parameters and fails (NO COERCION) on all except for the LiteralPath parameter. That tells us definitively how Get-Content is getting the path but it doesn't make sense. There is no LiteralPath property on a FileInfo object and there is no extended property called LiteralPath either.

This is where the second technique of using .NET Reflector can be used to see a decompiled version of the PowerShell source. After starting .NET Reflector and loading the Microsoft.PowerShell.Commands.Management.dll assembly, we search for and find the GetContentCommand and inspect the LiteralPath parameter shown below:

```
[Alias(new string[] { "PSPath" })]
[Parameter(Position = 0, ParameterSetName = "LiteralPath", Mandatory = true,
           ValueFromPipeline = false, ValueFromPipelineByPropertyName = true)]
public string[] LiteralPath { }
```

Note the Alias attribute on this parameter. It creates another valid name for the LiteralPath parameter, PSPath, which corresponds to the extended property PSPath that PowerShell adds to all *FileInfo* objects. That is what allows the *ByPropertyName* pipeline input binding to succeed. The *FileInfo* property PSPath matches the LiteralPath parameter albeit via an alias.

Where does that leave us? There are a number of cases where we can pipe an object directly to a cmdlet in the next stage of the pipeline because of pipeline input binding where PowerShell searches for the most appropriate parameter to bind that object to.

Here is another example of piping directly to another cmdlet without resorting to the use of the *Foreach-Object* cmdlet:

```
PS> Get-ChildItem *.txt | Rename-Item -NewName {$_.name + '.bak'}
```

You also now have a way to determine how PowerShell binds pipeline input to a parameter of a cmdlet. And thanks to Reflector we know that some parameters have aliases like PSPath to assist in this binding process.

That's it for *ByPropertyName* pipeline input binding. There is another type of pipeline input binding called *ByValue* that we will cover next.

Item 9: Understanding ByValue Pipeline Bound Parameters

ByValue pipeline parameter binding takes the input object itself, not one of its properties, and attempts to bind it by type using type coercion if necessary to parameters decorated as *ByValue*. For example, most of the *-Object utility cmdlets parameter bind *ByValue* to whatever object is presented to them via the pipeline. The help on Where-Object shows this:

```
-inputObject <psobject>
    Specifies the objects to be filtered. If you save the output of a command in a
    variable, you can use InputObject to pass the variable to Where-Object.
    However, typically, the InputObject parameter is not typed in the command.
    Instead, when you pass an object through the pipeline, Windows PowerShell
    associates the passed object with the InputObject parameter.


    Required?                    false
    Position?                    named
    Default value
    Accept pipeline input?       true (ByValue)
    Accept wildcard characters?  false
```

It turns out that *ByValue* isn't nearly as popular as *ByPropertyValue*. How can I make such a statement you ask? Well this is one of the things that I love about PowerShell. It provides so much metadata about itself. It is very self describing. You can easily walk every parameter on every cmdlet that is currently loaded into PowerShell. First let's see what information is available for a parameter:

```
PS> Get-Command -CommandType cmdlet | Select -Expand ParameterSets |
>>  Select -Expand Parameters -First 1 | Get-Member
>>

   TypeName: System.Management.Automation.CommandParameterInfo

Name                            MemberType Definition
----                            ---------- ----------
...
Aliases                         Property   System.Collections.ObjectModel.ReadOnlyCollection`1[[...
Attributes                      Property   System.Collections.ObjectModel.ReadOnlyCollection`1[[...
HelpMessage                     Property   System.String HelpMessage {get;}
IsDynamic                       Property   System.Boolean IsDynamic {get;}
IsMandatory                     Property   System.Boolean IsMandatory {get;}
Name                            Property   System.String Name {get;}
ParameterType                   Property   System.Type ParameterType {get;}
Position                        Property   System.Int32 Position {get;}
ValueFromPipeline               Property   System.Boolean ValueFromPipeline {get;}
ValueFromPipelineByPropertyName Property   System.Boolean ValueFromPipelineByPropertyName {get;}
ValueFromRemainingArguments     Property   System.Boolean ValueFromRemainingArguments {get;}
```

The interesting properties for us here are the Name and ValueFromPipeline* properties. Given this information it is easy to figure out how many of each type there are:

```
PS> (Get-Command -CommandType cmdlet | Select -Expand ParameterSets |
>>   Select -Expand Parameters |
>>   Where {$_.ValueFromPipeline -and !$_.ValueFromPipelineByPropertyName} |
>>   Measure-Object).Count
>>
55
PS> (Get-Command -CommandType cmdlet | Select -Expand ParameterSets |
>>   Select -Expand Parameters |
>>   Where {!$_.ValueFromPipeline -and $_.ValueFromPipelineByPropertyName} |
>>   Measure-Object).Count
>>
196
PS> (Get-Command -CommandType cmdlet | Select -Expand ParameterSets |
>>   Select -Expand Parameters |
>>   Where {$_.ValueFromPipeline -and $_.ValueFromPipelineByPropertyName} |
>>   Measure-Object).Count
>>
66
```

So from here we can see the following:

Type of Pipeline Binding	Count
ValueFromPipeline (ie ByValue)	55
ValueFromPipelineByPropertyName	196
Both	66

So indeed binding by property name is much more common. Binding by value from the pipeline is primarily for cmdlets that manipulate objects in a generic manner like filtering and sorting. In the query below we can see that the InputObject parameter is by far the most common ByValue pipeline bound parameter:

```
PS> Get-Command -CommandType cmdlet | Select -Expand ParameterSets |
>>  Select -Expand Parameters |
>>  Where {$_.ValueFromPipeline -and !$_.ValueFromPipelineByPropertyName} |
>>  Group Name -NoElement | Sort Count -Desc
>>

Count Name
----- ----
   40 InputObject
    4 Message
    3 String
    2 SecureString
    1 ExecutionPolicy
    1 Object
    1 AclObject
    1 DifferenceObject
    1 Id
    1 Command
```

A little further digging reveals the cmdlets that use the ByValue bound InputObject parameters as shown below. Note that a single parameter can appear in more than one parameter set on a cmdlet, which explains why there are only 36 cmdlets that account for the 40 instances of InputObject.

```
PS> $CmdletName = @{Name='CmdletName';Expression={$_.Name}}
PS> Get-Command -CommandType cmdlet | Select $CmdletName -Expand ParameterSets |
>>  Select CmdletName -Expand Parameters |
>>  Where {$_.ValueFromPipeline -and !$_.ValueFromPipelineByPropertyName} |
>>  Group Name | Sort Count -Desc | Select -First 1 | Foreach {$_.Group} |
>>  Sort CmdletName -Unique | Format-Wide CmdletName -AutoSize
>>

Add-History      Add-Member       ConvertTo-Html   Export-Clixml    Export-Csv      ForEach-Object
Format-Custom    Format-List      Format-Table     Format-Wide      Get-Member      Get-Process
Get-Service      Get-Unique       Group-Object     Measure-Command  Measure-Object  Out-Default
Out-File         Out-Host         Out-Null         Out-Printer      Out-String      Restart-Service
Resume-Service   Select-Object    Select-String    Sort-Object      Start-Service   Stop-Process
Stop-Service     Suspend-Service  Tee-Object       Trace-Command    Where-Object    Write-Output
```

As you can see most of these cmdlets are designed to deal with objects in general. Note to cmdlet developers - pipeline bound parameters is how your cmdlet receives pipeline objects. When writing a cmdlet in C# there isn't quite an equivalent of the $_ variable. If your cmdlet wants to "participate" in the pipeline it must set the ParameterAttribute property ValueFromPipeline and/or ValueFromPipelineByPropertyName to true on at least one of its parameters.

As mentioned above most *ByValue* parameters are of the InputObject (type psobject or psobject[]) variety so they pretty much accept anything. However not all cmdlets work that way. The -Id parameter (type [long[]]) on Get-History is pipeline bound *ByValue*. The follow Trace-Command output shows how PowerShell works hard when necessary to convert the input object's type to the expected type. In this case a scalar string value of '1' to an array of Int64:

```
PS> Trace-Command -Name ParameterBinding -PSHost -Expression {'1' | Get-History}

BIND NAMED cmd line args [Get-History]
BIND POSITIONAL cmd line args [Get-History]
MANDATORY PARAMETER CHECK on cmdlet [Get-History]
CALLING BeginProcessing
BIND PIPELINE object to parameters: [Get-History]
    PIPELINE object TYPE = [System.String]
    RESTORING pipeline parameter's original values
    Parameter [Id] PIPELINE INPUT ValueFromPipeline NO COERCION
    BIND arg [1] to parameter [Id]
        Binding collection parameter Id: argument type [String], parameter type
             [System.Int64[]], collection type Array, element type [System.Int64],
             no coerceElementType
        Creating array with element type [System.Int64] and 1 elements
        Argument type String is not IList, treating this as scalar
        BIND arg [1] to param [Id] SKIPPED
    Parameter [Id] PIPELINE INPUT ValueFromPipeline WITH COERCION
    BIND arg [1] to parameter [Id]
```

```
        COERCE arg type [System.Management.Automation.PSObject] to [System.Int64[]]
            ENCODING arg into collection
            Binding collection parameter Id: argument type  [PSObject], parameter type
                 [System.Int64[]], collection type Array, element type [System.Int64],
                 coerceElementType
            Creating array with element type [System.Int64] and 1 elements
            Argument type PSObject is not IList, treating this as scalar
            COERCE arg type [System.Management.Automation.PSObject] to [System.Int64]
                CONVERT arg type to param type using LanguagePrimitives.ConvertTo
                CONVERT SUCCESSFUL using LanguagePrimitives.ConvertTo: [1]
            Adding scalar element of type Int64 to array position 0
        Executing VALIDATION metadata:
[System.Management.Automation.ValidateRangeAttribute]
        BIND arg [System.Int64[]] to param [Id] SUCCESSFUL
MANDATORY PARAMETER CHECK on cmdlet [Get-History]
CALLING ProcessRecord
CALLING EndProcessing
```

Note that on the first attempt, PowerShell tries to convert the string to an array of Int64 and fails. Then it tries again by treating the input as psobject. It hands that psobject to an internal helper class LanguagePrimitives.ConvertTo() that successfully converts the string '1' to an Int64[] containing the value 1.

When a parameter is both ByValue and ByPropertyName bound, PowerShell attempts to bind in this order:

1. Bind ByValue with no type conversion
2. Bind ByPropertyName with no type conversion
3. Bind ByValue with type conversion
4. Bind ByPropertyName with type conversion

There is more to the parameter binding algorithm like finding the best match amongst different parameter sets. One last tidbit related to parameters. The PowerShell help topics aren't completely automatically generated and as a result they aren't always correct. For instance, look up the parameters on Get-Content and see if you find a -Wait parameter. You won't. However the metadata is always complete and correct e.g.:

```
PS> Get-Command Get-Content -Syntax
Get-Content [-Path] <String[]> [-ReadCount <Int64>] [-TotalCount <Int64>] [-Filter <String>]
  [-Include <String[]>] [-Exclude <String[]>] [-Force] [-Credential <PSCredential>] [-Verbose]
  [-Debug] [-ErrorAction <ActionPreference>] [-ErrorVariable <String>] [-OutVariable <String>]
  [-OutBuffer <Int32>] [-Delimiter <String>] [-Wait] [-Encoding <FileSystemCmdletProviderEncoding>]
Get-Content [-LiteralPath] <String[]> [-ReadCount <Int64>] [-TotalCount <Int64>] [-Filter <String>]
  [-Include <String[]>] [-Exclude <String[]>] [-Force] [-Credential <PSCredential>] [-Verbose]
  [-Debug] [-ErrorAction <ActionPreference>] [-ErrorVariable <String>] [-OutVariable <String>]
  [-OutBuffer <Int32>] [-Delimiter <String>] [-Wait] [-Encoding <FileSystemCmdletProviderEncoding>]
```

Hopefully this item has given you more knowledge about *ByValue* parameters and how to explore and get more information on cmdlet parameters in general. In summary, there actually isn't much you need to know about *ByValue* pipeline bound parameters because in most cases they just work intuitively. Just be sure to keep your eye out for those parameters that bind *ByPropertyName*. They are the ones whose pipeline bound usage isn't always as obvious.

Item 10: Error Handling

There are several facets to the subject of errors in PowerShell that you should understand to get the most out of PowerShell. Some of these facets are error handling, error related global variables and error related preference variables. But the most fundamental facet is the distinction between "terminating" and "non-terminating" errors.

Terminating Errors

Terminating errors will be immediately familiar to software developers who deal with exceptions. Unhandled exceptions will cause the program to crash. Similarly, if a terminating error is not handled it will cause the current operation (cmdlet or script) to abort with an error. Terminating errors and are generated by:

- Cmdlet calling the ThrowTerminatingError API.
- Exceptions escaping unhandled from a cmdlet
- Script using the *throw* keyword to issue a terminating error
- Script syntax errors

The gist of a terminating error is that the code throwing the terminating error is indicating that it cannot reasonably continue and is aborting the requested operation. As we will see later, you as the client of that code, have the ability to declare that you can handle the error and continue executing subsequent commands. Terminating errors that are not handled propagate up through the calling code, prematurely terminating each calling function or script until either the error is handled or the original invoking operation is terminated.

Here is an example of how a terminating error alters control flow:

```
PS> "Before"; throw "Oops!"; "After"
Before
Oops!
At line:1 char:16
+ "Before"; throw <<<<  "Oops!"; "After"
    + CategoryInfo          : OperationStopped: (Oops!:String) [], RuntimeException
    + FullyQualifiedErrorId : Oops!
```

Note that "After" is not output to the console because "throw" issues a terminating error.

Non-terminating Errors

Have you ever experienced the following in older versions of Windows Explorer? You open a directory with a large number of files, say your temp dir and you want to empty it. You select the entire contents of the directory, press Delete and wait. Unfortunately some processes invariably have files open in the temp directory. So after deleting a few files, you get an error from Windows Explorer indicating that it can't delete some file. You press OK and at this point Windows Explorer aborts the operation. It treats the error effectively as a terminating error. This can be very frustrating. You select everything again, press Delete, Explorer deletes a few more files then errors and aborts again. You rinse and repeat these steps until finally all the files that can be deleted are deleted. This behavior is very annoying and wastes your time. In an automation scenario, premature aborts like this are often unacceptable.

Having a special category of error that does not terminate the current operation is very useful in scenarios like the one outlined above. In PowerShell, that category is the non-terminating error. Even though a non-terminating error does not terminate the current operation, the error is still logged to the $Error collection (discussed later) as well as displayed on the host's console as is the case with terminating errors. Non-terminating errors are generated by:

- Cmdlet calling the WriteError API.
- Script using the Write-Error cmdlet to log a non-terminating error
- Exceptions thrown from calls to a member of a .NET object or type.

Here is an example of how a non-terminating error does not alter control flow:

```
PS> "Before"; Write-Error "Oops!"; "After"
Before
"Before"; Write-Error "Oops!"; "After" : Oops!
    + CategoryInfo          : NotSpecified: (:) [Write-Error], WriteErrorException
    + FullyQualifiedErrorId : Microsoft.PowerShell.Commands.WriteErrorException


After
```

Note the Write-Error command issues a non-terminating error that gets displayed on the host's console then the script continues execution.

Error Variables

There are several global variables and global preference variables related to errors. Here is a brief primer on them:

- **$?** - contains the execution status of the last operation. True indicates the operation succeeded without any errors. False indicates either complete failure or partial success. **Note:** for Windows executables the exit code is examined. An exit code of 0 will be interpreted as success and non-zero as failure. Some Windows console apps don't honor this convention so it is usually better to inspect $LASTEXITCODE such that you can determine for yourself success or failure based your interpretation of the exit code.
- **$LASTEXITCODE** – exit code of the last Windows executable invoked from this session.
- **$Error** – collection (ArrayList to be specific) of errors that have occurred in the current session. Errors are always inserted at the beginning of the collection. As a result, the most recent error is always located at index 0.
- **$MaximumErrorCount** – determines the size of the $Error collection. Defaults to 256 which is the minimum value allowed. Max value is 32768.
- **$ErrorActionPreference** – influences the dispatching of non-terminating errors. The default is 'Continue' which adds an entry to the $Error collection and displays the error on the host's console.
- **$ErrorView** – specifies one of two views for error records when they're displayed on the host. The default is 'NormalView' which displays several lines of information. For production environments, you

can set this to 'CategoryView' to get a succinct one line error message. Remember that all the details are still available in the $Error collection.

The $Error global variable can be used to inspect the details of up to the last $MaximumErrorCount number of errors that have occurred during the session e.g.:

```
PS> $error[0] | fl * -force


PSMessageDetails      :
Exception             : System.IO.IOException: The process cannot access the file '\Temp\FX
                        SAPIDebugLogFile.txt' because it is being used by another process.
                           at System.IO.__Error.WinIOError(Int32 errorCode, String
maybeFullPath)
                           at System.IO.FileInfo.Delete()
                           at
Microsoft.PowerShell.Commands.FileSystemProvider.RemoveFileSystemItem(FileSystemInfo file
                        SystemInfo, Boolean force)
TargetObject          : \Temp\FXSAPIDebugLogFile.txt
CategoryInfo          : WriteError: (\Temp\FXSAPIDebugLogFile.txt:FileInfo) [Remove-Item],
IOException
FullyQualifiedErrorId :
RemoveFileSystemItemIOError,Microsoft.PowerShell.Commands.RemoveItemCommand
ErrorDetails          : Cannot remove item \Temp\FXSAPIDebugLogFile.txt: The process cannot
                         access the file '\Temp\FXSAPIDebugLogFile.txt' because it is being
                         used by another process.
InvocationInfo        : System.Management.Automation.InvocationInfo
PipelineIterationInfo : {0, 1}
```

As the output above shows, errors in PowerShell are not just strings but rich objects. The object may be a .NET exception with an embedded error record or just an error record. The error record contains a lot of useful information about the error and the context in which it occurred.

The default output formatting of errors can be a bit hard to digest. The PowerShell Community Extensions come with a handy Resolve-Error function that digs through the error information and surfaces the important stuff e.g.:

```
PS> Resolve-Error # displays $error[0] by default
…
PS> Resolve-Error $error[1]
…
```

The $? global variable is handy for determining if the last operation encountered any errors e.g.:

```
PS> Remove-Item $env:temp\*.txt -Recurse -Verbose
VERBOSE: Performing operation "Remove File" on Target "...\Temp\foo.txt".
VERBOSE: Performing operation "Remove File" on Target "...\Temp\FXSAPIDebugLogFile.txt".
WriteError: (...\Temp\DebugLogFile.txt:FileInfo) [Remove-Item], IOException
PS> $?
False
```

In this case, the Remove-Item cmdlet only partially succeeded. It deleted two files but then encountered a non-terminating error. This failure to achieve complete success i.e. no errors, is indicated by $? returning False.

Working with Non-Terminating Errors

Sometimes you want to completely ignore non-terminating errors. Who wants all that red text spilled all over their console especially when you don't care about the errors you know you're going to get. You can suppress the display of non-terminating errors either locally or globally. To do this locally, just set the cmdlet's ErrorAction parameter to SilentlyContinue e.g.

```
Remove-Item $env:temp\*.txt -Recurse -Verbose -ErrorAction SilentlyContinue
```

For interactive scenarios it is handy to use 0 instead of SilentlyContinue. This works because SilentlyContinue is part of an enum and its integer value is 0. So to save your wrists you can rewrite the above as:

```
ri $env:temp\*.txt -r -v –ea 0
```

Note that for a script I would use the first approach for readability.

To accomplish the above globally, set the $ErrorActionPreference global preference variable to 'SilentlyContinue' (or 0). This will cause all non-terminating errors in the session to be suppressed so they do not show up on the host's console. However, errors will still be logged to the $Error collection.

Setting the $ErrorActionPreference to Stop can be useful in the following scenario. If you misspell a command, PowerShell will generate a non-terminating error as shown below:

```
PS> Copy-Itme .\_lesshst .\_lesshst.bak; $?; "After"
The term 'Copy-Itme' is not recognized as the name of a cmdlet, function, scrip
t file, or operable program. Check the spelling of the name, or if a path was i
ncluded, verify that the path is correct and try again.
At line:1 char:10
+ Copy-Itme <<<<  .\_lesshst .\_lesshst.bak; $?; "After"
    + CategoryInfo          : ObjectNotFound: (Copy-Itme:String) [], CommandNo
   tFoundException
    + FullyQualifiedErrorId : CommandNotFoundException

False
After
```

In this case, the misspelled Copy-Item command failed ($? returned False) but since the error was non-terminating, the script continues execution as shown by the output "After".

If you are hard-core about correctness you can get PowerShell to convert non-terminating errors into terminating errors by setting $ErrorActionPreference to Stop which has global impact. You can also do this one a cmdlet by cmdlet basis by setting the cmdlet's ErrorAction parameter to Stop.

The last issue to be aware of regarding non-terminating errors is that a Windows executable that returns a non-zero exit code does not generate any sort of error. The only action PowerShell takes is to set the $? variable to

False if the exit code is non-zero. There is no error record created and stuffed into $Error. In many cases, the failure of an external executable means your script cannot continue. In this case, it is desirable to convert a failure exit code into a terminating error. This can be done easily using the function below:

```
function CheckLastExitCode {
    param ([int[]]$SuccessCodes = @(0), [scriptblock]$CleanupScript=$null)

    if ($SuccessCodes -notcontains $LastExitCode) {
        if ($CleanupScript) {
            "Executing cleanup script: $CleanupScript"
            &$CleanupScript
        }
        $msg = @"
EXE RETURNED EXIT CODE $LastExitCode
CALLSTACK:$(Get-PSCallStack | Out-String)
"@
        throw $msg
    }
}
```

Note that Get-PSCallStack is specific to PowerShell v2.0. Invoke CheckLastExitCode right after invoking an executable, well at least for those cases where you care if an executable returns an error. This function provides a couple of handy features. First, you can specify an array of acceptable success codes which is useful for exes that return 0 for failure and 1 for success and is also useful for exes that return multiple success codes. Second, you specify a cleanup scriptblock that will get executed on failure.

Handling Terminating Errors

Handling terminating errors in PowerShell comes in two flavors. Using the trap keyword which is supported in both version 1 and 2 of PowerShell. Using try { } catch { } finally { } which is new to version 2.

Trap Statement

Trap is a mechanism available in other shell languages like Korn shell. It effectively declares that either any error type or a specific error type is handled by the scriptblock following the trap keyword. Trap has the interesting property that where ever it is declared in a scope, it is valid for that entire scope e.g.:

Given the following script (trap.ps1):

```
"Before"
throw "Oops!"
"After"
trap { "Error trapped: $_" }
```

Invoking it results in the following output:

```
PS> .\trap.ps1
Before
Error trapped: Oops!
Oops!
At C:\Users\Keith\trap.ps1:2 char:6
```

```
+ throw <<<<  "Oops!"
    + CategoryInfo          : OperationStopped: (Oops!:String) [], RuntimeException
    + FullyQualifiedErrorId : Oops!
After
```

Note that it doesn't matter that the trap statement is after the line that throws the error. Also note that since the default value for $ErrorActionPreference is 'Continue', the error is displayed, logged to $Error but execution resumes at the next statement. Note: within the context of a trap statement, $_ represents the error that was caught.

Another thing to consider is whether to use Write-Host or Write-Output to display text in the trap statement. The example above implicitly invokes the Write-Output cmdlet. This has the benefit that the text can be redirected to a log file. The downside is that if the exception is handled and execution continues that text will become part of the output for that scope which, in the case of functions and scripts, may not be desirable.

If you want to execute cleanup code on failure but still terminate execution, we can change the trap statement to use the break keyword. Consider the following script:

```
function Cleanup() {"cleaning up"}
trap { "Error trapped: $_"; continue }
"Outer Before"
& {
    trap { Cleanup; break }
    "Inner Before"
    throw "Oops!"
    "Inner After"
    Cleanup
}
"Outer After"
```

Note that the inner trap calls the Cleanup function but then propagates the error. As a result, the “Inner After” statement never executes because control flow is transferred outside the scope of the trap statement. The outer trap then catches the error, displays it and continues execution. As a result, the “Outer After” statement is executed.

The interaction between the control flow altering keywords valid in a trap statement (break, continue and return), the $ErrorActionPreference variable if no control flow altering keyword is used and the final behavior is somewhat complex as is demonstrated by the table below:

Trap Termination Style		Displays error	Propagates error
Keyword Used	No Keyword Used – depends on value of $ErrorActionPreference		
Break	Stop	True	True
Continue	SilentlyContinue	False	False
Return	Continue	True	False
Return <object> [1]	N/A	True	False
N/A	Inquire	Depends on response	Depends on response

1. <object> is appended to the end of the trap scope’s output.

All of the examples of trap shown above trap all errors. You may want to trap only specific errors. You can do this by specifying the type name of an exception to trap as shown below:

```
trap [System.DivideByZeroException] { "Please don't divide by 0!"}
$divisor = 0
1/$divisor
```

Note: Parse errors do not cause the trap block to execute. This is why I do not execute 1/0 in the example above. This is what would happen:

```
 trap [System.DivideByZeroException] { "Please don't divide by 0!"}
 1/0
Attempted to divide by zero.
At line:1 char:3
+ 1/ <<<< 0
    + CategoryInfo          : NotSpecified: (:) [], ParentContainsErrorRecordException
    + FullyQualifiedErrorId : RuntimeException
```

The reason our trap is not executed is that the PowerShell parser performs an operation known as constant folding when it parses the text "1/0". The divide by zero exception is generated at parse and as a result will not invoke your trap handler.

If you want to execute different code for different errors, you can define multiple trap statements in your script:

```
trap [System.DivideByZeroException] { "Please don't divide by 0!"}
trap [System.Management.Automation.CommandNotFoundException] {
    "Did you fat finger the command name?"
}
trap { "Anything not caught by the first two traps gets here" }
```

If you define multiple trap statements for the same error type the first one wins and the others within the same scope are ignored.

Try / Catch / Finally

Version 2 of Windows PowerShell introduces try/catch/finally statements - a new error handling mechanism that most developers will be immediately familiar with. There are two main differences between trap and try/catch/finally. First, a trap anywhere in a lexical scope covers the entire lexical scope. With a try statement, only the script within the try statement is checked for errors. The second difference is that trap doesn't support finally behavior i.e., always execute the finally statement whether the code in the try statement throws a terminating error or not. In fact, any associated catch statements could also throw a terminating error and the finally statement would still execute.

You can fake finally behavior with trap by calling the same "finally" code from the end of the lexical scope *and* from the trap statement. Consider the Cleanup function from the earlier example. We want to always execute Cleanup whether the script errors or not. The example shown in the previous section using the Cleanup function works OK unless the Cleanup function throws a terminating error. Then you run into the issue where

Cleanup gets called again due to the trap statement.   This sort of cleanup is much easier to represent in your script using try/finally e.g.:

```
function Cleanup($err) {"cleaning up"}
trap { "Error trapped: $_"; continue }

"Outer Before"
try {
    "Inner Before"
    throw "Oops!"
    "Inner After"
}
finally {
    Cleanup
}
"Outer After"
```

This example results in Cleanup always getting called whether or not the script in the try statement generates a terminating error. It also shows that you can mix and match trap statements with try/catch/finally.

One last example shows how you can use catch to handle different error types uniquely:

```
function Cleanup($err) {"cleaning up"}
trap { "Error trapped: $_"; continue }

"Outer Before"
try {
    "Inner Before"
    throw "Oops!"
    "Inner After"
}
catch [System.DivideByZeroException] {
    "Please don't divide by 0!"
}
catch [System.Management.Automation.CommandNotFoundException] {
    "Did you fat finger the command name?"
}
catch {
    "Anything not caught by the first two catch statements gets here"
}
finally {
    Cleanup
}
"Outer After"
```

The use of the finally statement is optional as is the catch statement. The valid combinations are try/catch, try/finally and try/catch/finally.

In summary, PowerShell's error handling capabilities are quite powerful especially the ability to distinguish between non-terminating and terminating errors. With the addition of the new try/catch/finally support in version 2.0 the important scenario of resource cleanup is easy to handle.

Item 11: Regular Expressions - One of the Power Tools in PowerShell

Windows PowerShell is based on the .NET Framework. That is, it is built using the .NET Framework and it exposes the .NET Framework to the user. One very nice feature of the .NET Framework is the Regex class in the *System.Text.RegularExpressions* namespace. It is a very capable regular expression engine. PowerShell uses this regular expression engine in a number of scenarios:

- -match operator
- -notmatch operator
- Select-String -Pattern parameter

Obviously to get the most out of these operators and the Select-String cmdlet it helps to have a good grasp of regular expressions. PowerShell provides a help topic named "about_Regular_Expression" that you can view like so:

```
PS> help about_reg*
```

This topic provides a nice quick reference on the various meta-characters in a regular expression but you are not going to learn a great deal about creating powerful regular expressions. To learn how to get the most out of regular expressions and hence PowerShell, I highly recommend Jeffrey Friedl's book *Mastering Regular Expressions*.

There is a shortcoming in PowerShell's support for regular expressions that you need to know about. Most other script languages support regular expression syntaxes where you can find all matches in a string. For example in Perl I could do this:

```
$_ = "paul xjohny xgeorgey xringoy stu pete brian";  # PERL script
($first, $second, $third) = /x(.+?)y/g;
```

Unfortunately the Select-String cmdlet doesn't have this feature in version 1.0. For now you can work around this limitation by using the *System.Text.RegularExpressions.Regex* class directly. Fortunately you don't have to type that long class name because PowerShell has a type alias: [regex]. For example:

```
PS> $str = "paul xjohny xgeorgey xringoy stu pete brian"
PS> $first,$second,$third = ([regex]'x(.+?)y').Matches($str) | Foreach {$_.Groups[1].Value}
PS> $first
john
PS> $second
george
PS> $third
ringo
```

One thing to watch out for is when your regular expression is written to search across line boundaries. For instance, if you use Get-Content to grab the contents of a file to apply the regular expression against, keep in mind that Get-Content streams the file one line at a time. For regular expressions that operate across lines you will need to apply the regex to the file contents represented as a single string. In that case, I would do this in PowerShell 1.0:

```
PS> $regex = [regex]'(?<CMultilineComment>/\*[^*]*\*+(?:[^/*][^*]*\*+)*/)'
PS> Get-Content foo.c | Join-String -Newline | Foreach {$regex.Matches($_)} |
>>  Foreach {$_.Groups["CMultilineComment"].Value}
>>
```

Note the use of the PowerShell Community Extensions cmdlet Join-String which takes the individual strings output by Get-Content and creates a single string. Also note that this example shows the usage of a named capture: CMultilineComment. This example demonstrates that when PowerShell is missing a feature, the access that it provides to the .NET Framework is a great escape hatch.

PowerShell 2.0 Update

Fortunately PowerShell 2.0 introduces a number of new features that help with the search above. First, there is a new join operator that joins multiple strings into a single string. Second, Select-String has been updated with a number of new parameters such as -Context, -NotMatch and -AllMatches. The AllMatches parameter is what we needed above and is why we resorted to using the regex directly. This is how you would perform the same comment search in PowerShell 2.0:

```
$pattern = '(?<CMultilineComment>/\*[^*]*\*+(?:[^/*][^*]*\*+)*/)'
PS> (get-content .\foo.c) -join "`n" | Select-String $pattern -all | Foreach {$_.Matches} |
Foreach {$_.Value}
```

Regular expressions are an extremely powerful aspect of PowerShell. Learn them and they will open up many opportunities to find and manipulate text.

Item 12: Comparing Arrays

PowerShell has a lot of useful operators such as -contains which tests if an array contains a particular element. But as far as I can tell PowerShell doesn't seem to provide an easy way to test if two array's contents are equal. This is often quite handy and I was a bit surprised by this apparent omission.

I came upon this need to compare arrays while answering a question on the *microsoft.public.windows.powershell* newsgroup. The poster wanted to find utf-8 encoded files by inspecting their BOM or byte order mark. One relatively straight forward approach to this is:

```
PS> $preamble = [System.Text.Encoding]::UTF8.GetPreamble()
PS> $preamble | foreach {"0x{0:X2}" -f $_}
0xEF
0xBB
0xBF
PS> $fileHeader = Get-Content Utf8File.txt -Enc byte -Total 3
PS> $fileheader | foreach {"0x{0:X2}" -f $_}
0xEF
0xBB
0xBF
```

While it is easy enough to visually inspect this and see we have a match, visual inspection doesn't work in a script. You could also test each individual element which isn't bad for a three element array but when you hit say 10 elements that approach starts to look tedious.

You might think that we could just compare these two arrays directly like so:

```
PS> $preamble -eq $fileHeader | Get-TypeName
WARNING: Get-TypeName did not receive any input. The input may be an empty collection. You can either
prepend the collection expression with the comma operator e.g. ",$collection | gtn" or you can pass
the variable or expression to Get-TypeName as an argument e.g. "gtn $collection".
PS> $preamble -eq 0xbb
187
```

Note: Get-TypeName is a filter function provided by the PowerShell Community Extensions.

Comparing arrays via the -eq operator doesn't actually compare the contents of two arrays. As you can see above, this results in no output. When the left hand side of the -eq operator is an array, PowerShell return the elements of the array that match the value specified on the right hand side (shown above where I test for -eq to 0xbb).

It looks like we need to roll our own mechanism to compare arrays. Here is one way:

```
function AreArraysEqual($a1, $a2) {
    if ($a1 -isnot [array] -or $a2 -isnot [array]) {
      throw "Both inputs must be an array"
    }
    if ($a1.Rank -ne $a2.Rank) {
      return $false
    }
    if ([System.Object]::ReferenceEquals($a1, $a2)) {
      return $true
    }
    for ($r = 0; $r -lt $a1.Rank; $r++) {
      if ($a1.GetLength($r) -ne $a2.GetLength($r)) {
            return $false
      }
    }

    $enum1 = $a1.GetEnumerator()
    $enum2 = $a2.GetEnumerator()
    while ($enum1.MoveNext() -and $enum2.MoveNext()) {
      if ($enum1.Current -ne $enum2.Current) {
            return $false
      }
    }
    return $true
}
```

And it works as expected:

```
PS> AreArraysEqual $preamble $fileHeader
True
```

However there turns out to be a way to do this within PowerShell but it isn't exactly obvious. At least it wasn't to me.

```
PS> @(Compare-Object $preamble $fileHeader -sync 0).Length -eq 0
True
```

Compare-Object will compare the arrays and if there are no differences it won't output anything. If we wrap the output of Compare-Object in an array subexpression @() then we will get an array with either 0 or more elements. A simple compare of the length to 0 will confirm that there was no output, hence the arrays are equal.

Compare-Object compares two objects to see if they have the same set of elements. Normally it does not care if the elements are in the same sequence in each object (each array in this case). For example:

```
PS> $a1 = 1,1,2
PS> $a2 = 1,2,1
PS> @(Compare-Object $a1 $a2).length -eq 0
True
```

Obviously that isn't what we want when comparing arrays for equality. Fortunately, we can use the SyncWindow parameter with a value 0 to get Compare-Object to force sequence equality.

Let's compare the performance of these two approaches:

```
PS> $a1 = 1..10000
PS> $a2 = 1..10000
PS> (Measure-Command { AreArraysEqual $a1 $a2 }).TotalSeconds
1.236252
PS> (Measure-Command { @(Compare-Object $a1 $a2 -sync 0).Length -eq 0 }).TotalSeconds
0.3259954
```

Compare-Object beats out my PowerShell function by a good margin which isn't too surprising[1]. After all, one is compiled code and the other is interpreted script. So there you have it. If you need a quick way to compare to arrays, just remember that arrays are objects too and that is what Compare-Object does best - compare two objects.

Item 13: Use Set-PSDebug -Strict In Your Scripts - Religiously

Windows PowerShell is like most dynamic languages in that it allows you to use a variable without declaring its type and without having assigned to it. This is handy for interactive use, you can do stuff like this:

```
PS> Get-ChildItem | Foreach -Process {$sum += $_.Name.Length} -End {$sum}
```

[1] Except for comparing against the same array where my function is two orders of magnitude faster. It seems that the Compare-Object cmdlet could benefit from a quick System.Object.ReferenceEquals check. Admittedly this is a corner case scenario.

Here *$sum* isn't a defined variable and yet we are adding a value to it and assigning to it. PowerShell just assumes a value of $null and coerces that 0 in the case above. Try this at the prompt:

```
PS> $xyzzy -eq $null
True
```

It is not likely that this variable is already defined somewhere. Of course we could verify that as shown below to see that indeed it isn't defined.

```
PS> Test-Path Variable:\xyzzy
False
```

What has this got to do with using Set-PSDebug -Strict in scripts - religiously? Well, once you get burned by an unfortunate typo that takes time to notice and time to track down, you will want a way to avoid repeating that mistake. Take this script for example:

```
$suceeded = test-path C:\ProjectX\Src\BuiltComponents\Release\app.exe

if ($succeeded) {
    ... <archive bits, label build, etc>
}
else {
    ... <email team that build failed, etc>
}
```

This script has a problem with it that PowerShell won't tell you about. It will happily indicate that every build fails even though that may not be true. This is all because of a minor typo where I misspelled $succeeded when testing the path. In this snippet, the typo may be obvious to you but when you have several hundred lines of script, typos aren't always so obvious.

You can prevent this particular problem by placing Set-PSDebug -Strict at the top of your script file just after the param() statement (if any). For example, given this script as Foo.ps1:

```
Set-PSDebug -Strict

$suceeded = test-path C:\ProjectX\Src\BuiltComponents\Release\app.exe

if ($succeeded) {
    "yeah"
}
else {
    "doh"
}

PS C:\Temp> .\foo.ps1
The variable $succeeded cannot be retrieved because it has not been set yet.
At C:\Temp\foo.ps1:6 char:14
+ if ($Succeded) <<<<  {
```

What would have happened if we had omitted the Set-PSDebug -Strict invocation? This script would have output "doh". Note: In some cases we may need to initialize a variable in order to avoid the error above. This is a small price to pay to avoid this sort of problem. The title of this item was perhaps a bit "over the top". There may very well be times not to use Set-PSDebug -Strict in your scripts. As always, use your judgment.

PowerShell 2.0 Update

In PowerShell 2.0, you should use the new cmdlet Set-StrictMode like so:

```
param(...)
Set-StrictMode  -version Latest
<rest of your script>
```

Set-StrictMode checks for more than just the use of uninitialized variables. It will also check for references to non-existent properties, calling functions using .NET method calling syntax and unnamed variables e.g. ${}.

Item 14: Commenting Out Lines in a Script File

Windows PowerShell 1.0 doesn't provide multiline comments although that oversight has been rectified in 2.0 as I'll show you at the end of this section. If you are using PowerShell 2.0 exclusively you still might want to read this section as it covers some gotchas when using *here* strings. Multiline comments come in handy when you need to comment out multiple lines in a script file. However there is a reasonable workaround. Use a *here* string. A *here* string allows you to enter multiple lines of text and prevent PowerShell from interpreting commands. However the extent of PowerShell's interpretation depends on which type of *here* string you use. For instance, in double quoted *here* strings, PowerShell expands variables and also executes subexpressions. This is an example of a double quoted *here* string that results in script being evaluated e.g.:

```
PS> @"
>> $(get-process)
>> "@
>>
System.Diagnostics.Process (audiodg) System.Diagnostics.Process (csrss) ...
```

However a single quoted *here* string doesn't do this:

```
PS> @'
>> $(get-process)
>> '@
>>
$(get-process)
```

Use the single quoted *here* string to comment out lines of script since it will not evaluate anything in the *here* string. Just note, the *here* string is an expression so if you do nothing more, the whole string will be emitted to the console. You don't usually want that when you are commenting out code. To prevent this, all you need to do is cast the string to [void] (or redirect the string to $null) as shown below:

```
[void]@'
"Getting process info"
get-process | select Name, Id
"Killing all vd processes"
stop-process -name vd*
'@
```

This will effectively comment out those lines of script. Note: There are a couple of gotchas to be aware of with *here* strings. There can be no whitespace after the initial @' character sequence. If there is one single space after this sequence you will get the following cryptic error:

```
Unrecognized token in source text.
At C:\Temp\foo.ps1:1 char:1
+ @ <<<< '
```

The other gotcha is that the closing '@ character sequence has to start in column zero otherwise you get this equally cryptic error message:

```
Encountered end of line while processing a string token.
At C:\Temp\foo.ps1:1 char:3
+ @' <<<<
```

The final gotcha to watch out for is that you can't nest *here* strings in PowerShell 1.0 within another *here* string of the same ilk (single quoted or double quoted). What this means for our commenting out script scenario is that you won't be able to surround a chunk of script that uses a single quoted here strings with another single quoted here string to comment out that code.

PowerShell 2.0 Update

PowerShell 2.0 introduces a proper support for multiline comments as shown below.

```
<#
This is a
multiline comment
in PowerShell 2.0
#>
```

Finally, *here* strings in PowerShell 2.0 can be nested as shown in the example below:

```
@"
<Processes>
  $(Get-Process | Foreach {
@"
  <Process name="$($_.name)" id="$($_.id)" workingSet="$($_.ws)">`r`n
"@
  })
</Processes>
"@
```

Item 15: Using the Output Field Separator Variable $OFS

$OFS is the “output field separator” variable. Whatever value it contains will be used as the string separator between elements of an array that is rendered to a string. For example, consider the following array definition and subsequent rendering to string:

```
PS> $array = 1,2,3
PS> "$array"
```

What would you expect the resulting string to be? Here’s the output:

```
1 2 3
```

How does PowerShell go about rendering elements of an array into a single string? It is pretty simple as you would expect. Each element is converted to its string representation. The only other detail left is to determine what characters to use to separate each element in the final string. The $OFS variable is not initially created by PowerShell and if it doesn’t exist, PowerShell uses a single space character to separate elements as you can see in the example above. What is neat is that PowerShell gives you the ability change the separator string by setting the $OFS variable like this:

```
PS> $OFS = ', '
PS> "$array"
1, 2, 3
```

Note that the separator doesn’t have to be single character. It doesn’t even have to be a string, but in the end whatever value that is assigned to $OFS is converted to a string e.g.:

```
PS> $OFS = $true
PS> "$array"
1True2True3
```

This is an admittedly weird example. In the common case, you will just assign a string to $OFS like ", " or "`t" or "`n", etc.

$OFS also works for multi-dimensional arrays e.g.:

```
PS> $array = new-object 'int[,]' 2, 3
PS> $array[0,0] = 1
PS> $array[0,1] = 2
PS> $array[0,2] = 3
PS> $array[1,0] = 4
PS> $array[1,1] = 5
PS> $array[1,2] = 6
PS> $OFS = ', '
PS> "$array"
1, 2, 3, 4, 5, 6
```

Unfortunately, $OFS doesn’t work so well for jagged arrays:

```
PS> $array = @(@(1,2),@(3,4))
PS> $OFS = ', '
PS> "$array"
System.Object[], System.Object[]

# Let's try a different approach - not so satisfying
PS> "$($array[0]), $($array[1])"
1, 2, 3, 4
```

When I see folks use [string]::Join() or –join in version 2 of PowerShell, I wonder if it would be better to use $OFS and string rendering. Here is an example I came across recently:

```
$typeDecls  = @($_.GetGenericArguments() | %{"[string]`$Of" + $_.Name}) –join ', '
$paramDecls = @($_.GetParameters() | % { "[$($_.ParameterType)]`$$($_.Name)" }) –join ', '

$decls = $typeDecls
$decls += $(if ($decls –and $paramDecls) { ', ' })
$decls += $(if ($paramDecls) { $paramDecls })

function New-$fname($decls) { … }
```

Using $OFS the script changes to:

```
$OFS = ', '
$typeDecls  = @($_.GetGenericArguments() | %{"[string]`$Of" + $_.Name})
$paramDecls = @($_.GetParameters() | % { "[$($_.ParameterType)]`$$($_.Name)" })

$decls = $typeDecls + $paramDecls

function New-$fname("$decls") { … }
```

In this example, the use of $OFS shines because you benefit by delaying the string rendering of the arrays until the last moment. In this case, I wanted to keep both $typeDecls and $paramDecls as arrays so that they could be concatenated together and then rendered as a string containing a comma separated list. If these two variables had been converted to strings earlier, as in the "before" script above, then you need special case logic in the event $typeDecls and/or $paramDecls are empty.