

French PowerShell Saturday



PowerShell Classes Part2: Advanced Concepts and feedback from the field

Stéphane van Gulick

15 Septembre 2018 - #FrPwshSat2018



French PowerShell Saturday

Merci à nos sponsors !!



 METSYS


smartview
conseil et formation

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Introduction

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Introduction



```

1 Function Get-Speaker {
2     $speaker =[Ordered] @{
3         "Name" = "van Gulick"
4         "FirstName" = "Stéphane"
5         "WorkPlace" = "Bern"
6         "isMVP" = $true
7     }
8     return New-Object psobject -Property $speaker
9 }
10
11
12
13 Get-Speaker
14

```

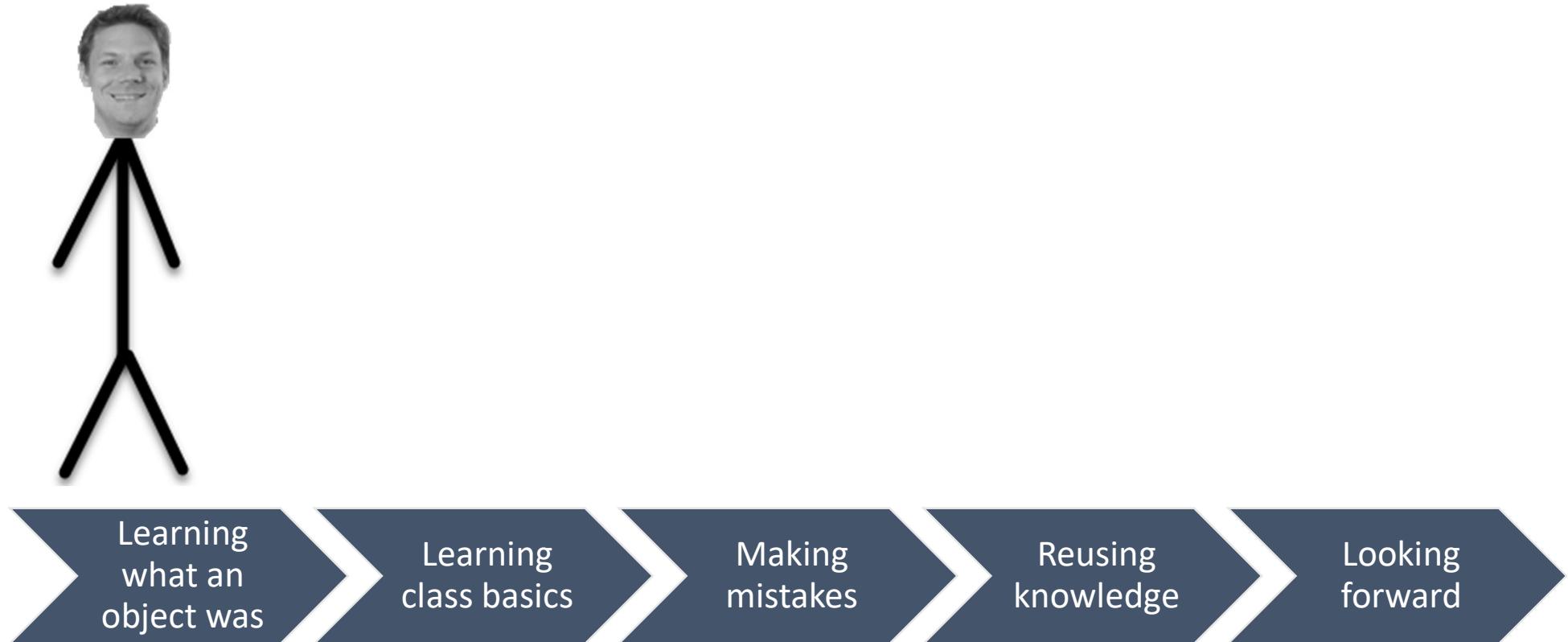
PROBLEMS TERMINAL ... 1: PowerShell Integrated + ⌂ ⌂

Name	FirstName	WorkPlace	isMVP
van Gulick	Stéphane	Bern	True

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Plan:



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Learning from the begining

The struggle

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Introduction: assimilating class concepts



Function

```
1 Function User {
2     [CmdletBinding()]
3     Param(
4
5         [Parameter(Mandatory=$true)][String]$FirstName,
6         [Parameter(Mandatory=$true)][String]$LastName
7
8     )
9
10    $Hash = @{
11        FirstName = $FirstName
12        LastName = $LastName
13        FullName = $Name + " " + $LastName
14    }
15
16    return New-object psobject -Property $Hash
17
18 }
19
20 user -FirstName "Stéphane" -LastName "van Gulick"
```

Class

```
Class User {
    #Properties
    [String]$FirstName
    [String]$LastName
    [String]$FullName

    #Constructor

    User ([String]$FirstName,[String]$LastName){
        $this.FirstName = $FirstName
        $this.LastName = $LastName
        $this.SetFullName()
    }

    #Methods

    [void]SetFullName(){
        $this.FullName = $this.Name + " " + $this.LastName
    }

    [String]GetFullName(){
        return $this.FullName
    }
}
```

Click!



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Class Basics

```
00_BasicClass.ps1 x
1 Class User {
2     #Properties
3         [String]$Name
4         [String]$LastName
5         [String]$FullName
6
7     #Constructor
8
9     User ([String]$FirstName, [String]$LastName){
10        $this.Name = $FirstName
11        $this.LastName = $LastName
12        $this.SetFullName()
13    }
14
15    #Methods
16
17    [void]SetFullName(){
18        $this.FullName = $this.Name + " " + $this.LastName
19    }
20
21    [String]GetFullName(){
22        return $this.FullName
23    }
24 }
25 [User]::New("Stephane", "van Gulick")
```

- **Properties:**
 - Holds information on the object
- **Constructor:**
 - Creates your object
- **Methods:**
 - Adds functionality to your object (Like a Function)
- **Creating an object (Instantiate):**
 - New-Object ClassName
 - [ClassName]::New()

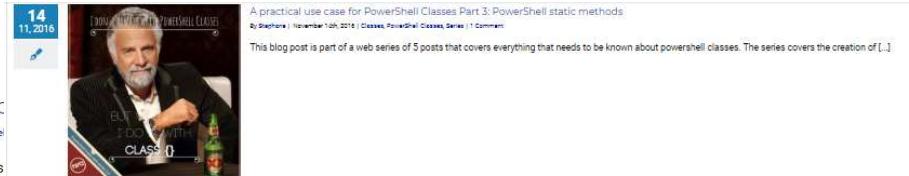


Plan:



A practical use case for PowerShell Classes
By Stephane | October 18th, 2016 | Powershell 5, PowerShell

In part two of this web series about powershell use a powershell enum and go through a us



A practical use case for PowerShell Classes Part 3: PowerShell static methods

By Stephane | November 10th, 2016 | Classes, PowerShell Classes, Series | 1 Comment

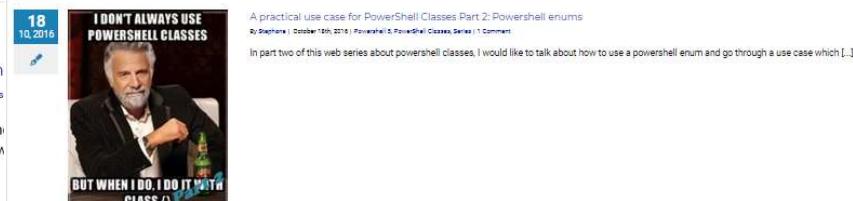
This blog post is part of a web series of 5 posts that covers everything that needs to be known about powershell classes. The series covers the creation of [...]



French PowerShell Meetup n°2 – Wrap up

By Stephane | October 20th, 2016 | French, PowerShell Classes, UserGroup | 0 Comments

Not so long ago, we have founded the French PowerShell user group. The second meetup was held yesterday, where I did a presentation on PowerShell Classes (Read more about [...])



A practical use case for PowerShell Classes Part 2: Powershell enums

By Stephane | October 18th, 2016 | Powershell 5, PowerShell Classes, Series | 1 Comment

In part two of this web series about powershell classes, I would like to talk about how to use a powershell enum and go through a use case which [...]



A practical case for using a PowerShell Class

By Stephane | June 6th, 2015 | Powershell, PowerShell Classes, Series | 12 Comments

I recently got curious about how a powershell class works. After digging a bit into it, I have to admit: I actually love it! Using a Powe



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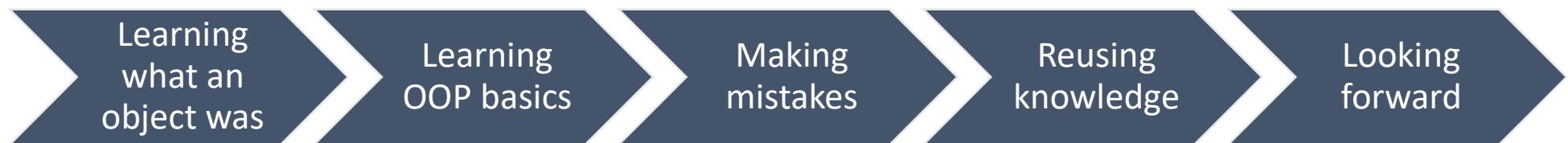
Plan:

\$False

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Plan:



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OOP Concepts

Programming guidelines

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OOP: What's that?



Object Oriented Programming



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4 pillars of OOP:



Abstraction



Encapsulation



Inheritance



Polymorphism

4 Pillars of OOP: Abstraction



Abstraction

```
1735 Function Test-PackageDocument {  
1736     <#...  
1737     #>  
1738     [CmdletBinding()]  
1739     Param(  
1740         [Parameter(Mandatory=$true)]  
1741         [PackageDocument]$Document  
1742     )  
1743     return $Document.ValidateDocument()  
1744 }  
1745 }
```

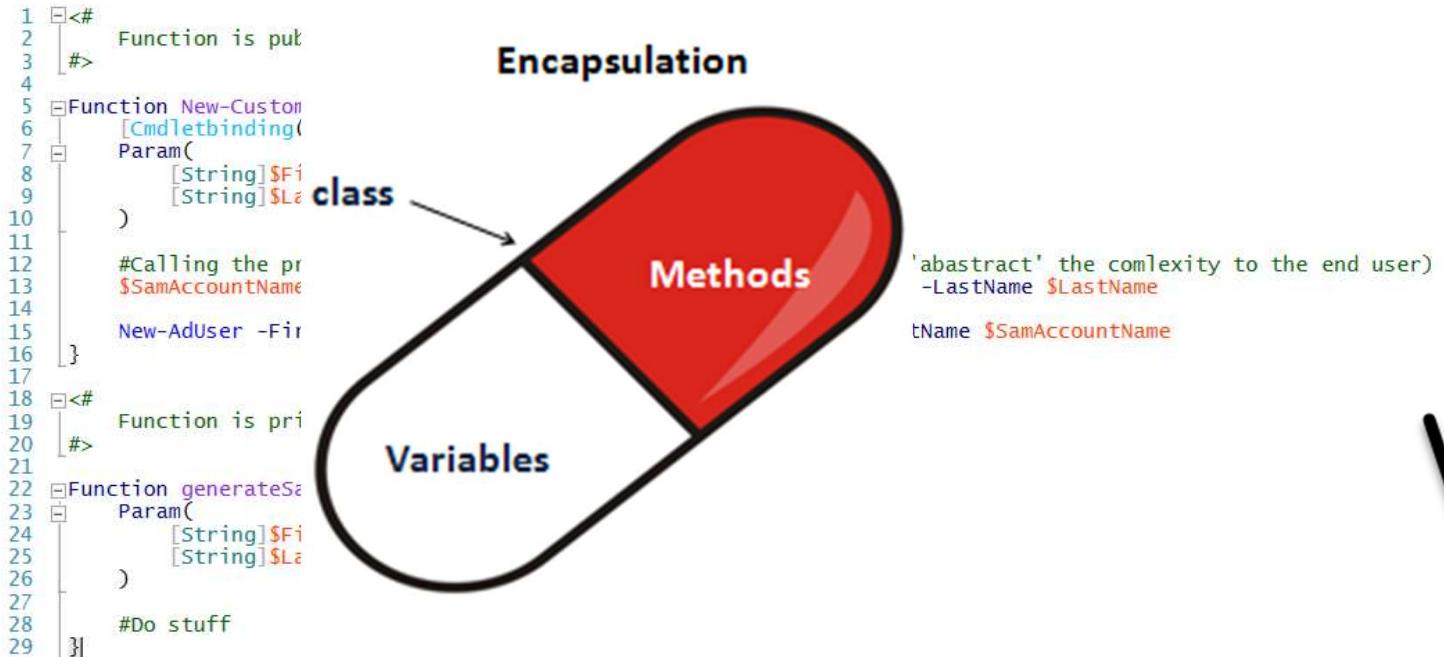


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4 Pillars of OOP: encapsulation



encapsulation

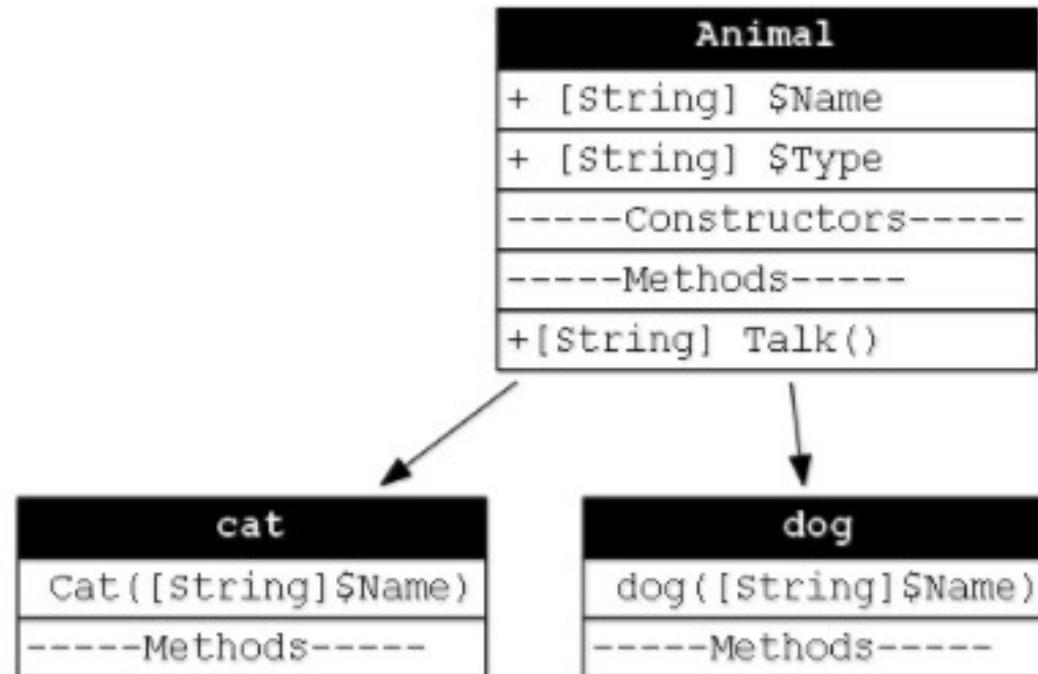


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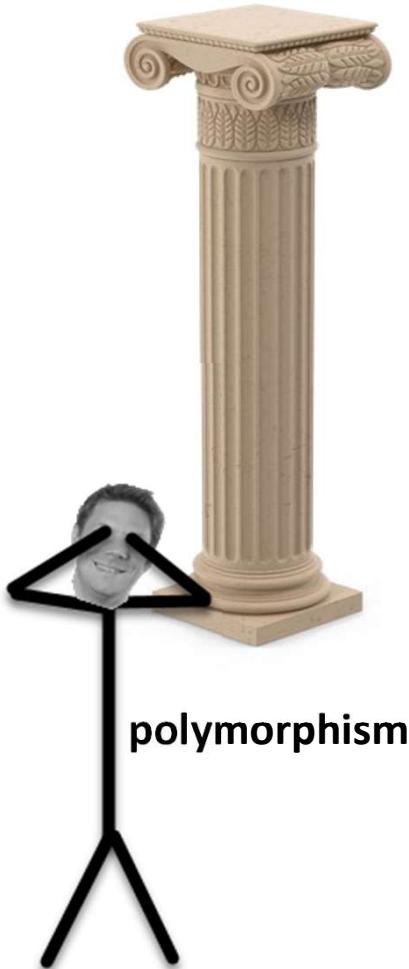
4 Pillars of OOP: inheritance



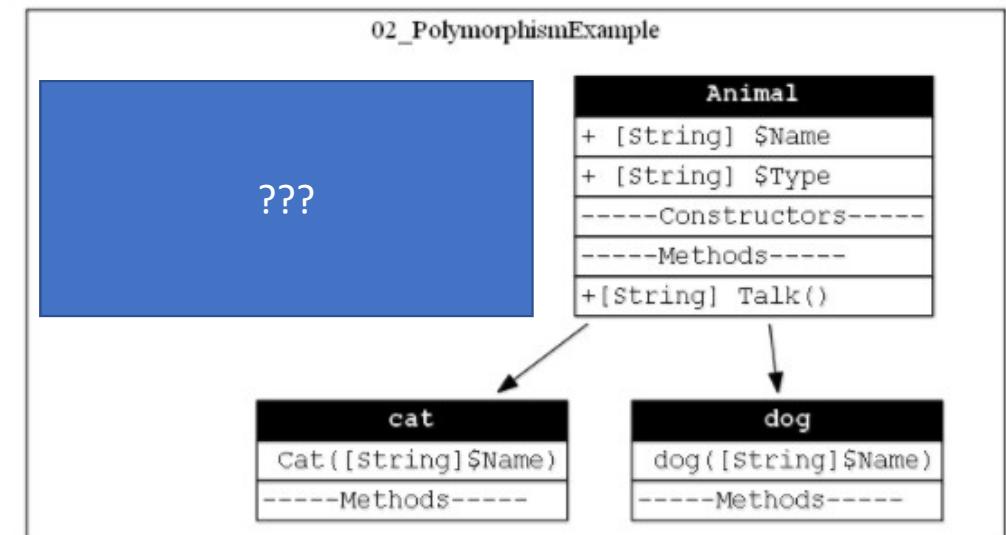
inheritance



4 Pillars of OOP: polymorphism



```
1 class Animal {
2     [String]$Name
3     [String]$Type
4
5     [String]Talk(){
6         return "Hi I am a $($this.type) and my name is $($this.Name)"
7     }
8 }
9
10 class cat : Animal {
11
12     Cat([String]$Name){
13         $this.Name = $Name
14         $this.Type = "Cat"
15     }
16 }
17
18
19 class dog : Animal {
20
21     dog([String]$Name){
22         $this.Name = $Name
23         $this.Type = "Dog"
24     }
25 }
26
27
28 class Boat {
29     [Animal[]]$Passengers = @()
30
31     Boat([Animal[]]$Passengers){
32         $this.Passengers += $Passengers
33     }
34 }
35
36 $Array = @()
37 $Array += [Cat]::new("Minnie")
38 $Array += [Cat]::new("Jerry")
39 $Array += [dog]::new("Rex")
40 $Array += [dog]::new("Goofy")
41
42 $NohasBoat = [Boat]::New($Array)
43
44 Foreach($Passenger in $NohasBoat.Passengers){
45     $Passenger.Talk()
46 }
```



```
$NohasBoat = [Boat]::New($Array)

Foreach($Passenger in $NohasBoat.Passengers){
    $Passenger.Talk()
}
Hi I am a Cat and my name is Minnie
Hi I am a Cat and my name is Jerry
Hi I am a Dog and my name is Rex
Hi I am a Dog and my name is Goofy
```



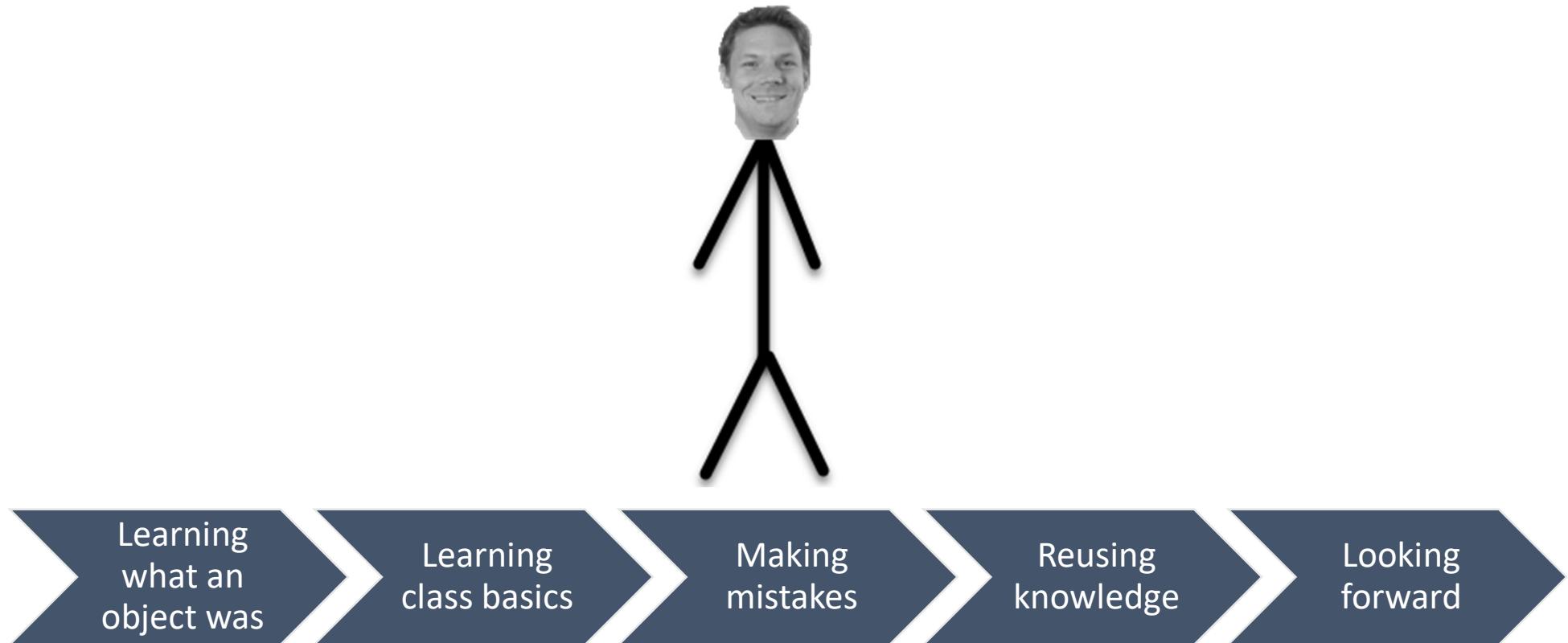
Open Source projects using Powershell Classes

My own 'creations' and some really cool ones

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Plan:



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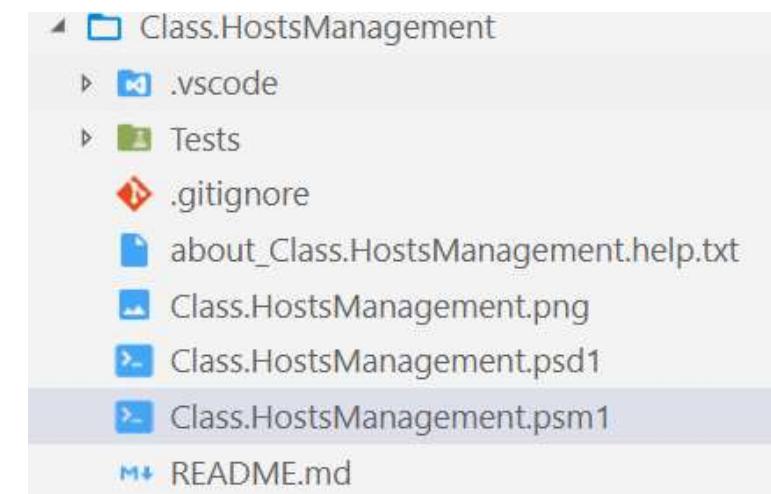
Class.HostsManagement: Me (Stéphane van Gulick)



Simple classes + Enum -> <https://github.com/Stephanevg/Class.HostsManagement>

```
Class.HostsManagement.psm1 ✘

StephaneG, a year ago | 2 authors (Stéphane van Gulick and others)
1 Enum HostsEntryType{
2     Entry
3     Comment
4     BlankLine
5 }
6
7 Class HostsEntry{
8     [Ipaddress]$IpAddress
9     [string]$Hostname
10    [String]$FullyQualifiedNames
11    [String]$Description
12    [HostsEntryType]$EntryType
13
14    HostsEntry(([IpAddress]$IpAddress,[String]$HostName,[String]$FQDN,[String]$Description,[HostsEntryType]$Type){...}
15
16    HostsEntry(([IpAddress]$IpAddress,[String]$HostName,[String]$FQDN,[String]$Description){...}
17
18    HostsEntry([String]$Comment,[HostsEntryType]$Type){...}
19
20    hidden HostsEntry([string]$Line){...}
21
22    HostsEntry(){...}
23
24    [HostsEntryType] static hidden GetLineType([string]$Line){...}
25
26
27 Class HostsFile{
28     hidden [HostsEntry[]]$Entries
29     [string]$Path
30     hidden [int]$LogRotation = 5
31
32     HostsFile(){...}
33
34     HostsFile([String]$ComputerName){...}
35
36     HostsFile([System.IO.FileSystemInfo]$Path){...}
37
38     [void]ReadHostsFileContent(){...}
39
40     [array]GetEntries(){...}
41
42     [void]AddHostsEntry([HostsEntry[]]$entries){...}
43
44     [void]RemoveHostsEntry([HostsEntry[]]$entries){...}
45
46     [void]Backup([System.IO.DirectoryInfo]$BackupFolder){...}
47
48     [void]Backup(){...}
49     <#...
50     | [void]Set(){...}
51
52
53 }
```



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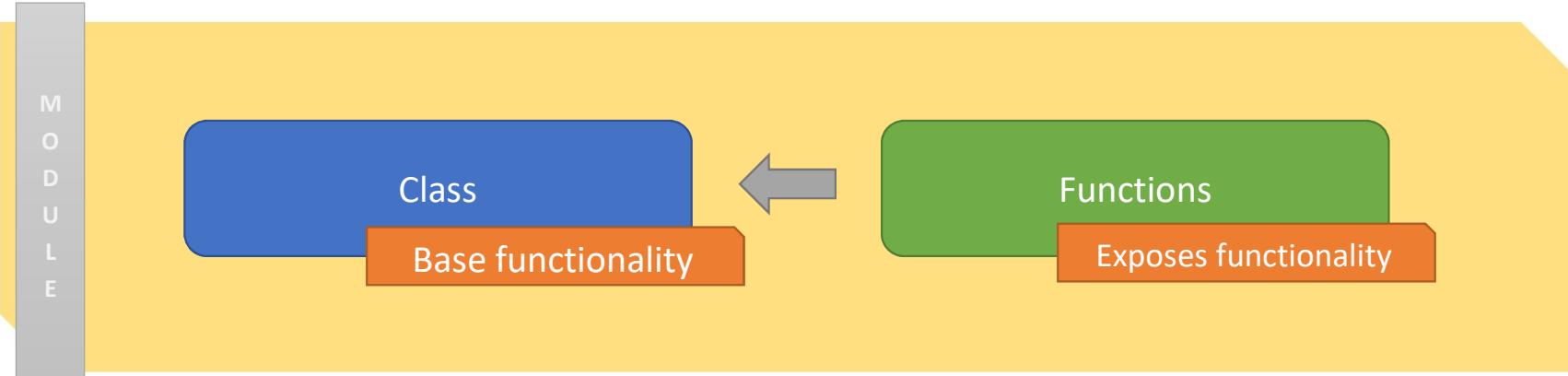
Feedback

Feedback Received:



- How does it work?
- How do I load the module?
- How can I do **\$Something**
- Where is the help? (get-Help?)

My recommendation: Module Structure using classes



```

1  Class PackageDocument {
2      [system.io.Fileinfo]$File
3      [DocumentType]$Type
4      [CMPackage]$Document
5      [String]$SiteCode = (Get-CMSiteCode)
6
7      PackageDocument() {...}
8
9      PackageDocument([String]$File) {...}
10
11     [PackageDocument]AddPackage([CMPackage]$CMPPackage) {...}
12
13     [PackageDocument] ExportDocument() {...}
14
15     [string] static GetDocumentTemplate([DocumentType]$Type) {...}
16
17     [string] SetSiteCode([String]$Sitecode) {...}
18
19     SetPsDrive() {...}
20
21     [Bool]validateDocument() {...}
22
23 }
```

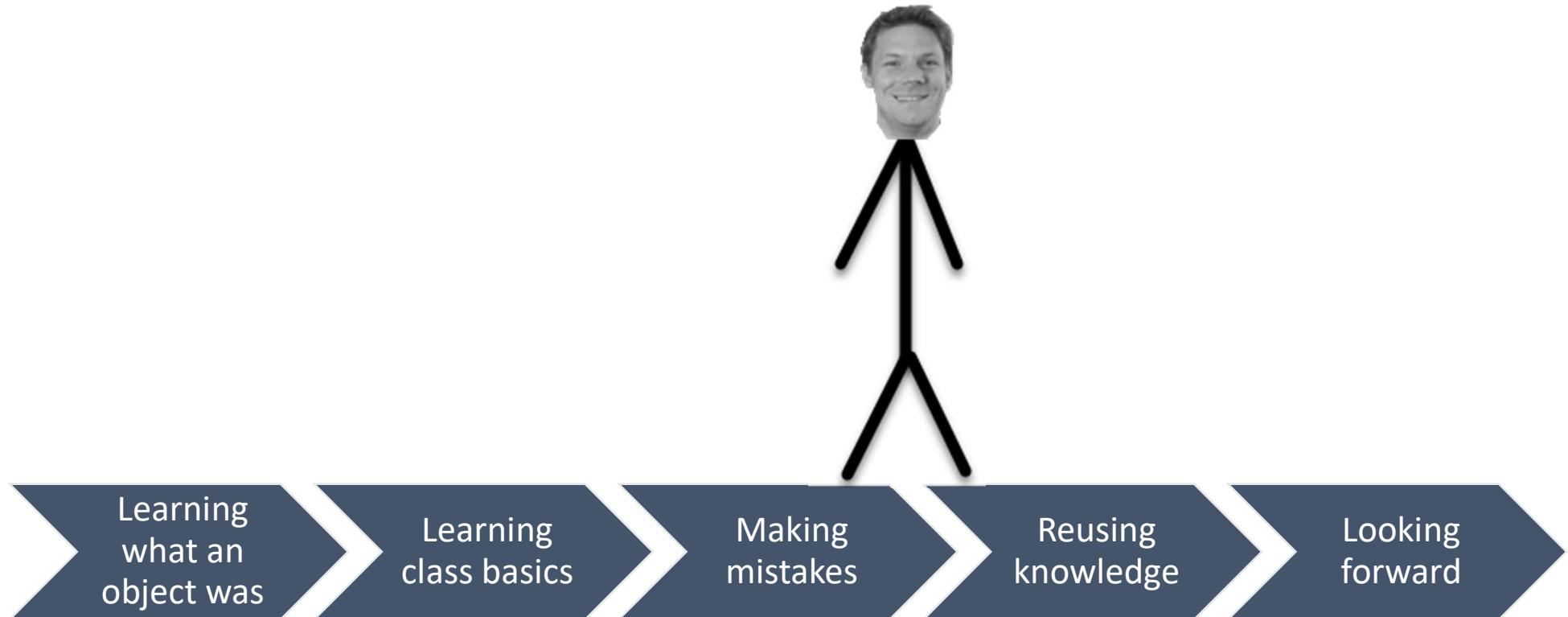
```

Function Get-PackageDocument {
    [CmdletBinding()]
    Param(
        [String]$Path
    )
    if ($Path) {
        $Document = Get-PackageDocument -Path $Path
        return $Document
    }
}

Function Test-PackageDocument {
    <#...
    #
    [CmdletBinding()]
    Param(
        [Parameter(Mandatory=$true)]
        [PackageDocument]$Document
    )
    return $Document.ValidateDocument()
}
```

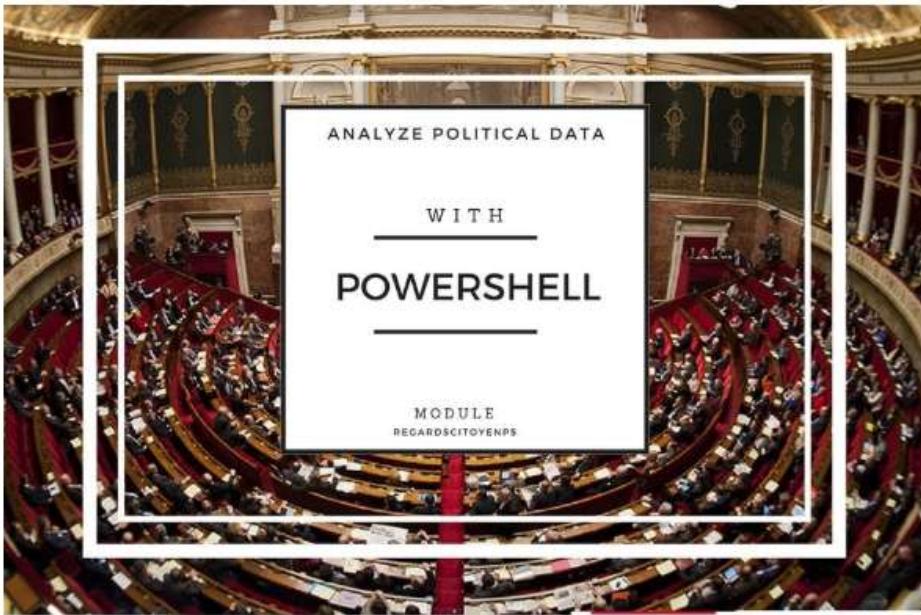


Plan:



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Learning by doing (the right way)



Updated

- Encapsulated functionality in class methods. Exposed via classic powershell functions.
- Added functions to module (New-blabla, Get-Blabla etc..)
- Added comment based help in functions
- Added About_help file
- Used ScriptsToProcess



Simplify import of modules using classes

A screenshot of a PowerShell IDE interface. At the top, there are four tabs: 'RegardsCitoyenPS.psd1', 'RegardsCitoyenPS.psd1', 'LoadClasses.ps1', and 'RegardsCitoyenHelpers.psm1'. The 'RegardsCitoyenPS.psd1' tab is active and shows a large amount of PowerShell script code. The 'LoadClasses.ps1' tab shows a snippet of code starting with '1 using', and the 'RegardsCitoyenHelpers.psm1' tab shows a snippet of code starting with '2 |'. The code in the active tab includes definitions for classes like 'GroupePolitique', 'Mandat', 'Depute', 'Synthese', 'Intervention', and 'Dossier', along with various properties and methods. The code uses a mix of English and French terms, such as 'RequiredModule', 'RequiredAssembly', 'Script files', and 'ScriptsToProcess'. The overall theme is the simplification of module imports through the use of classes.

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Example from the field



```
198 Class Dossier {
199     [int]$id
200     [String]$Titre
201     [Datetime]$MinDate
202     [DateTime]$MaxDate
203     [int]$NbInterventions
204     [Object[]]$Intervenants
205     [Intervention[]]$Seances
206     [String[]]$Documents
207     [String[]]$SousSection
208     hidden [string[]]$id_intervenants
209     hidden [string[]]$id_seances
210     hidden [string[]]$id_documents
211     hidden [string[]]$id_soussections
212
213
214     Dossier([int]$id,[String]$Titre,[int]$NbInterventions,[DateTime]$minDate
215
216     hidden [Void] _LoadIntervenants(){...}
217
218     hidden [void] _LoadSeances(){...}
219
220     hidden [Void] _LoadDocuments(){
221
222         write-verbose "Chargement des seances.."
223         if ($this.id_documents){
224             $Docs += @()
225             foreach ($id in $this.id_documents){
226
227                 $Docs += Get-RCDocument -id $id
228             }
229
230             $this.Documents = $Docs
231
232         }
233
234     }
235
236     hidden [Void] _LoadSousSections(){...}
237
238
239     [Dossier] Full(){
240         $this._LoadSeances()
241         $this._LoadDocuments()
242         $this._LoadIntervenants()
243
244         return $this
245     }
246 }
```

```
1 Function Get-RCDossier {
2     <#...
78
79
80     [cmdletBinding(DefaultParameterSetName="all")]
81     Param(
82
83         [Parameter(Mandatory=$false, ParameterSetName="id")]
84         [ValidateNotNullOrEmpty()]
85         [String]$id,
86
87         [Parameter(Mandatory=$false)]
88         [Switch]$Full
89
90     )
91
92     switch ($PsCmdlet.ParameterSetName) {
93
94
95         "All"{
96
97             try{
98                 $data = Invoke-RestMethod -Uri $RC_data.urls.Dossiers -ErrorAction Stop
99             }Catch [System.Net.WebException]{
100                 write-warning "Server indisponible: Merci de vérifier votre connection internet."
101                 break
102
103             }Catch{
104                 $_.exception.message
105             }
106
107             Foreach ($entry in $Data.sections.section){
108
109                 $ret = (invoke-restmethod $Entry.url_nosdeputes_api).Section
110
111                 $id_seances = $ret.seances.seance.id
112                 $id_intervenants = $ret.intervenants.parlementaire.slug
113                 $id_soussections = $ret.soussections.soussection.id
114                 $id_documents = $ret.documents.document.id
115
116                 $Dos = [Dossier]::New($ret.id,$ret.Titre,$ret.nb_interventions,$ret.min_date,$ret.max_date,$id_intervenants,$id_seances)
117
118                 if ($Full){
119
120                     $Dos.Full()
121
122                 }else{
123
124
125             }
126
127         }
128
129     }
130
131 }
```



PsClassUtils – Stéphane van Gulick (me)

Simple classes

```
1 Class ClassProperty {
2     [String]$Name
3     [String]$Type
4
5     ClassProperty([String]$Name,[String]$Type){
6
7         $this.Name = $Name
8         $This.Type = $Type
9     }
10 }
```

```
1 Class ClassParameter {
2     [String]$Name
3     [String]$Type
4
5     ClassParameter([String]$Name,[String]$Type){
6
7         $this.Name = $Name
8         $This.Type = $Type
9     }
10 }
```

```
1 Class ClassMethod {
2     [String]$Name
3     [String]$ReturnType
4     [ClassParameter[]]$Parameter
5
6     ClassMethod([String]$Name,[String]$ReturnType,[ClassParameter[]]$Parameters){
7         $this.Name = $Name
8         $This.ReturnType = $ReturnType
9         $This.Parameter = $Parameters
10    }
11 }
12 }
```

Unsaved changes (cannot determine recent change or authors)

```
1 Class ClassConstructor {
2     [String]$Name
3     [ClassParameter[]]$Parameter
4
5     ClassConstructor([String]$Name,[ClassParameter[]]$Parameter){
6         $this.Name = $Name
7         $This.Parameter = $Parameter
8     }
9
10 }
```

The screenshot shows a file explorer window with the following structure:

- Classes (parent folder)
 - 00_ClassProperty.ps1
 - 01_ClassParameter.ps1
 - 02_ClassMethod.ps1 (selected)
 - 03_ClassConstructor.ps1
- Private

Polaris – Microsoft



<https://github.com/PowerShell/Polaris> - (5 'big' classes)

The screenshot shows a PowerShell script editor window with the following details:

- Title Bar:** The title bar displays "Polaris.Class.ps1" and "PolarisResponse.Class.ps1".
- Left Sidebar:** A tree view on the left lists the structure of the "Polaris" class, including its properties, methods, and nested classes.
- Code Editor:** The main area contains the PowerShell script code for the "Polaris" class. The code includes imports for System.Collections.Generic, System.Net.HttpListener, and System.IO.Stream. It defines a class "Polaris" with various methods like "InvokeRoute", "AddRoute", "RemoveRoute", "Send", "SendByte", "Start", "Stop", "InitListener", "Send", "SetHeader", "SetStatus", "SetContent", "SetStream", and "Log". It also includes static methods for "SanitizePath", "ConvertPathToRegex", and "AddMiddleware".
- Bottom Status Bar:** The status bar at the bottom shows "28 / 1".
- Right Panel:** A sidebar titled "lib" lists several files: "MimeTypes.Class.ps1", "Polaris.Class.ps1" (selected), "PolarisMiddleware.Class.ps1", "PolarisRequest.Class.ps1", and "PolarisResponse.Class.ps1".



PoshBot – Brandon Olin

<https://github.com/poshbotio/PoshBot>

```

1 # An access filter controls under what conditions
2 class AccessFilter {
3
4     [Chachka\AccessPermissions] $Permissions = &{<
5         2
6             class BaseLogger {
7                 3
8                     2 # In charge of executing and tracking
9                     3 class CommandExecutor : BaseLogger {
10                         4
11                             5 [BotLogger]$Logger
12                         6
13                             7 hidden [Bot]$_bot
14                         8
15                             9 [int]$HistoryToKeep = 100
16                         10
17                             11 [int]$ExecutedCount = 0
18                         12
19                             13 # Recent history of commands e>
20                             14 [System.Collections.ArrayList]$_
21                             15
22                             16 # Plugin commands get executed
23                             17 # This is to keep track of those
24                             18 hidden [hashtable]$_jobTracker
25
26                             19 CommandExecutor([RoleManager]$RoleManager, $this.$RoleManager = $RoleManager)
27                             20 $this.Logger = $Logger
28                             21 $this._bot = $Bot
29
30                             22
31
32                             23 # Execute a command
33                             24 [void]ExecuteCommand([Command]$cmd)
34
35                             25 # Verify command is not disabled
36                             26 if (-not $cmdExecutionContext.C
37                                 27 $err = [CommandDisabled]$cmdExecutionContext.Complet
38                                 28 $cmdExecutionContext.Ended = $true
39                                 29 $cmdExecutionContext.Result =
40                                 30 $cmdExecutionContext.Result =
41                                 31 $this.LogInfo([LogSeverity]$err)
42                                 32 $this.TrackJob($cmdExecutionContext)
43                                 33 return
44
45
46                             34 # Verify that all mandatory
47                             35 # This doesn't apply to cmdlets
48                             36 if ($cmdExecutionContext.Command)
49                                 37 if (-not $this.ValidateCommand($cmd))
50                                     38 $msg = "Mandatory parameter(s) missing or incorrect: "
51                                     39 foreach ($usage in $cmd.Usage)
52                                         40 $msg += " $usage"
53                                     41
54                                     42
55                                     43
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```



My key take aways:

- 1) Write core logic in classes
- 2) abstract functionality in public methods.
- 3) Expose functionality to end users through functions (cmdlets)
- 4) Load functions through ScriptsToProcess





Taking advantage of existing knowledge

Don't re-invent the wheel

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Plan:



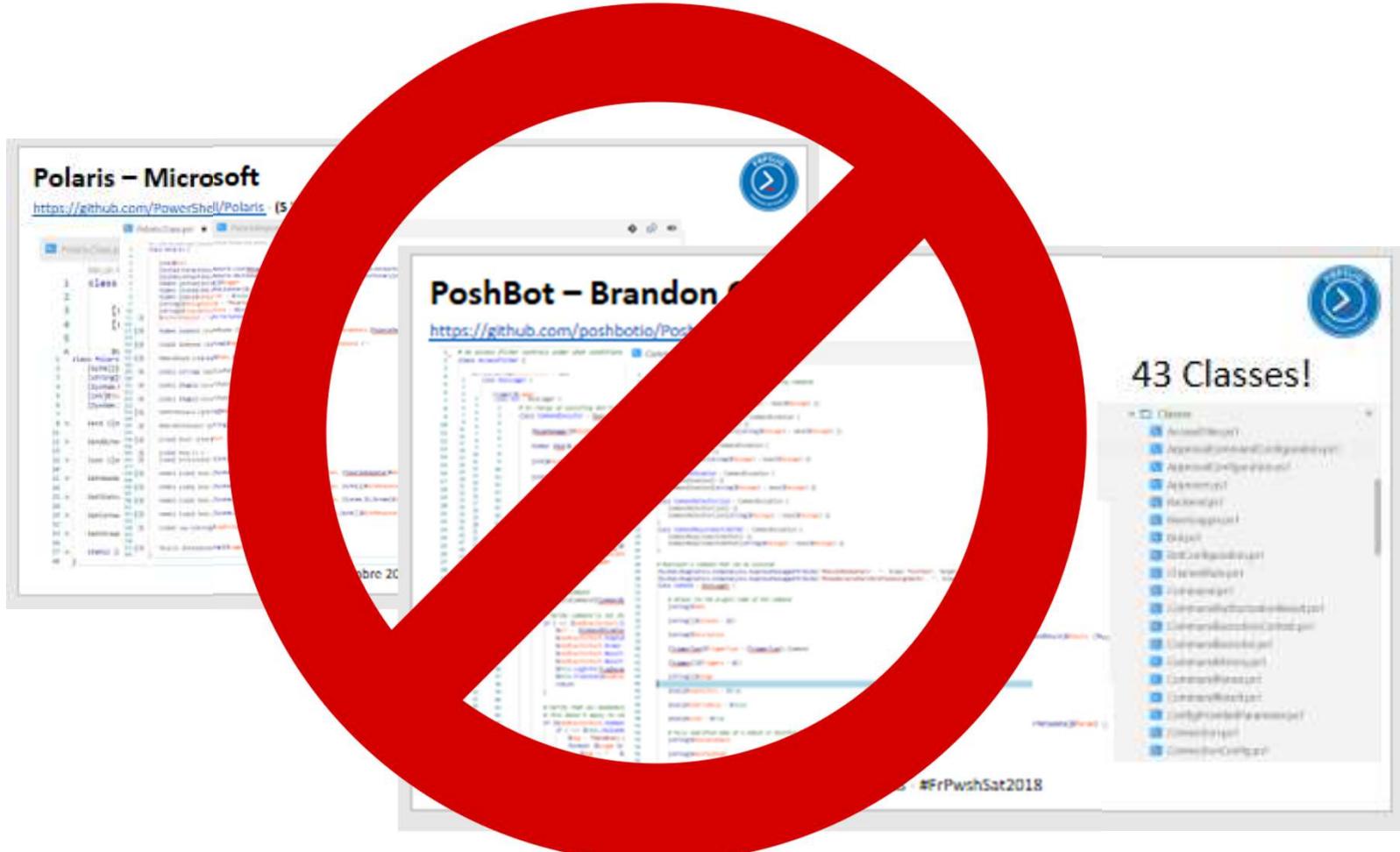
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Communicate via diagrams: UML

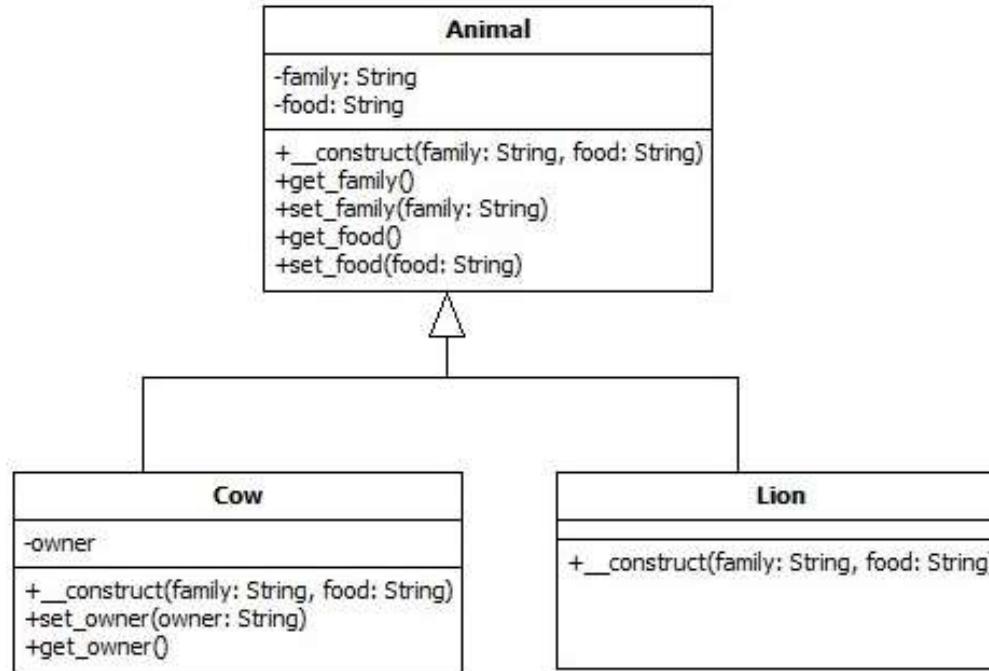
A picture is worth a
thousand words

Communicate via images using UML diagrams



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Communicate via images using UML diagrams





Generate your own diagrams for your own scripts

PSClassUtils

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Generate your own diagrams for your own scripts

```
> find-module psclassutils | install-module
```

CommandType	Name	Version	Source
Function	ConvertTo-titleCase	2.1.0	psclassutils
Function	Get-CUClass	2.1.0	psclassutils
Function	Get-CUClassConstructor	2.1.0	psclassutils
Function	Get-CUClassMethod	2.1.0	psclassutils
Function	Get-CUClassProperty	2.1.0	psclassutils
Function	Write-CUClassDiagram	2.1.0	psclassutils



UML Diagrams

Visual communication

```
Class User {
    #Properties
    [String]$FirstName
    [String]$LastName
    [String]$FullName

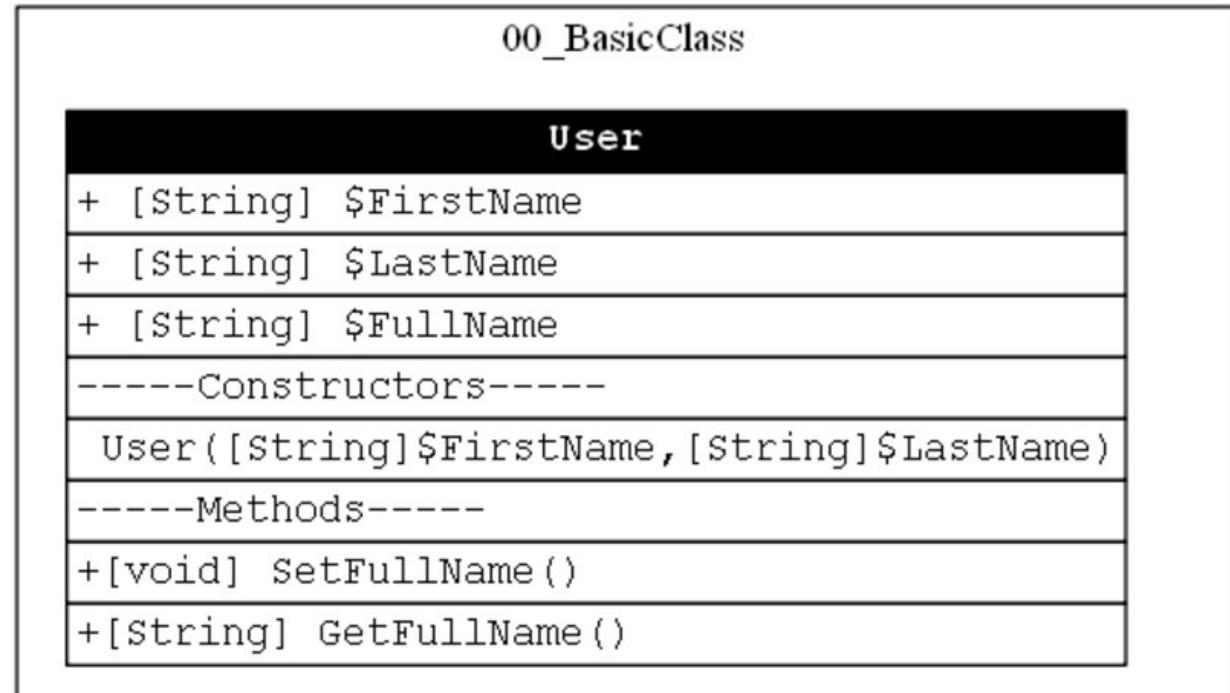
    #Constructor

    User ([String]$FirstName,[String]$LastName){
        $this.FirstName = $FirstName
        $this.LastName = $LastName
        $this.SetFullName()
    }

    #Methods

    [void]SetFullName(){
        $this.FullName = $this.Name + " " + $this.LastName
    }

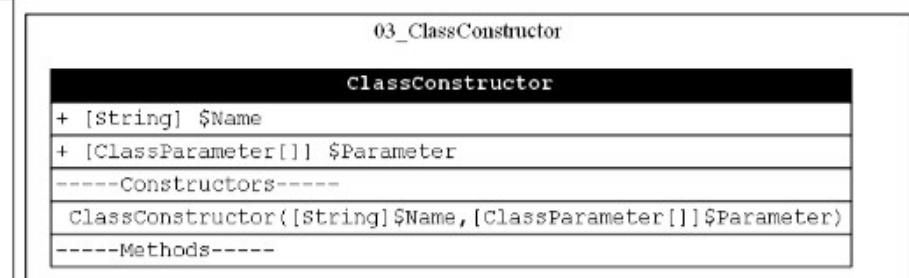
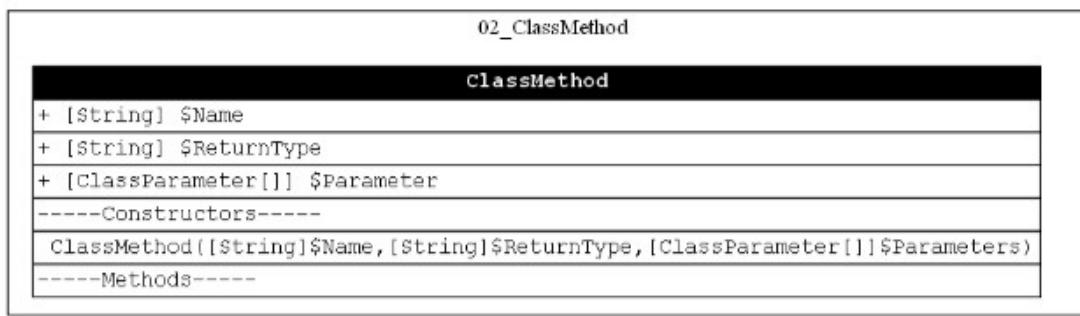
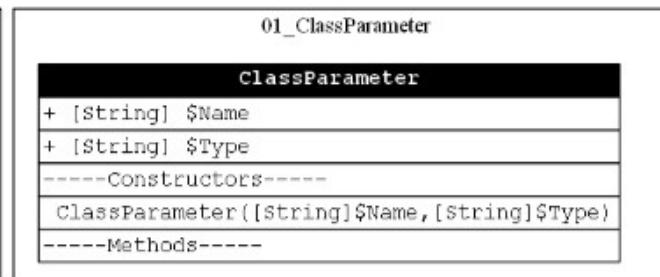
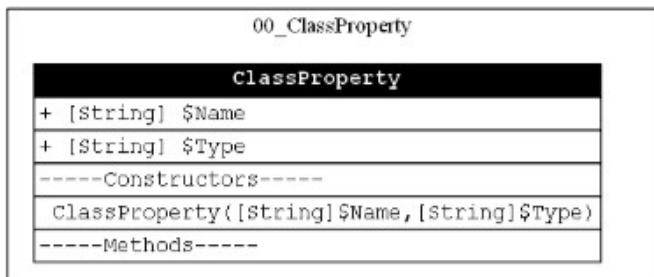
    [String]GetFullName(){
        return $this.FullName
    }
}
```





PsClassUtils – Stéphane van Gulick (me)

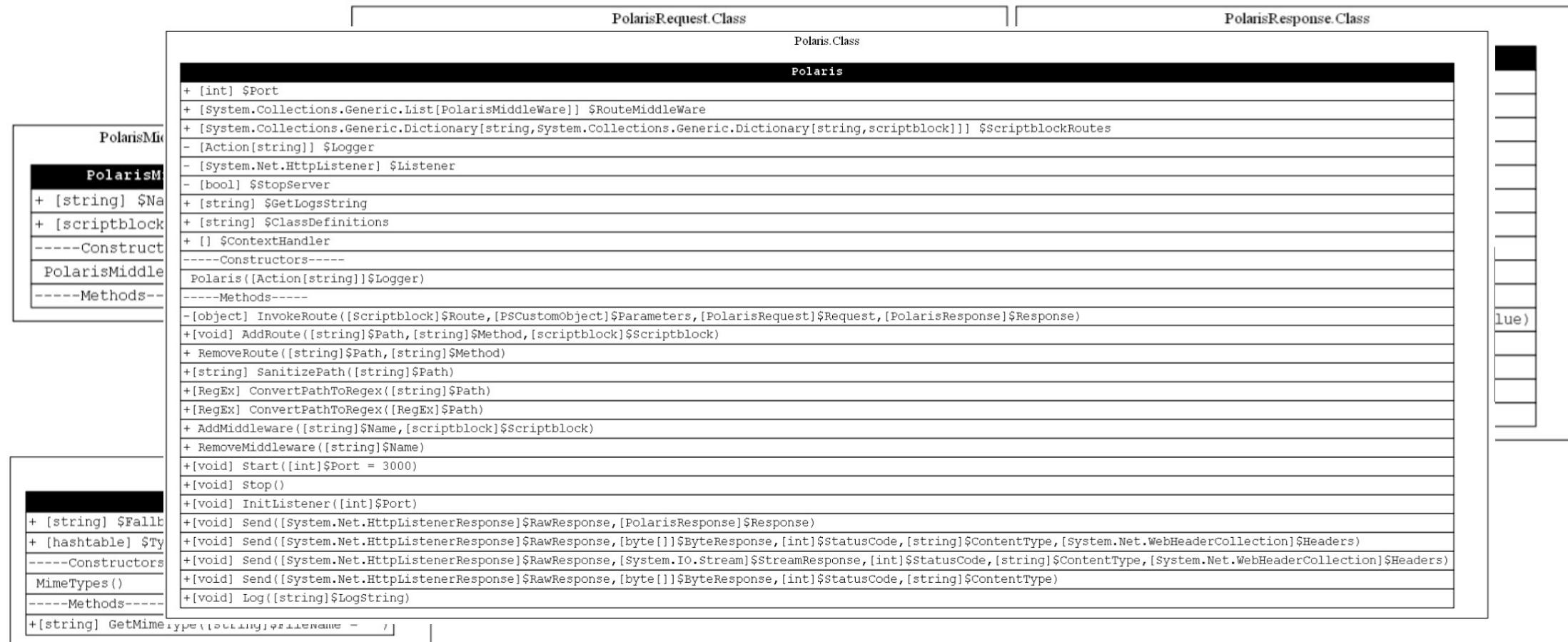
Simple class





Polaris - Microsoft

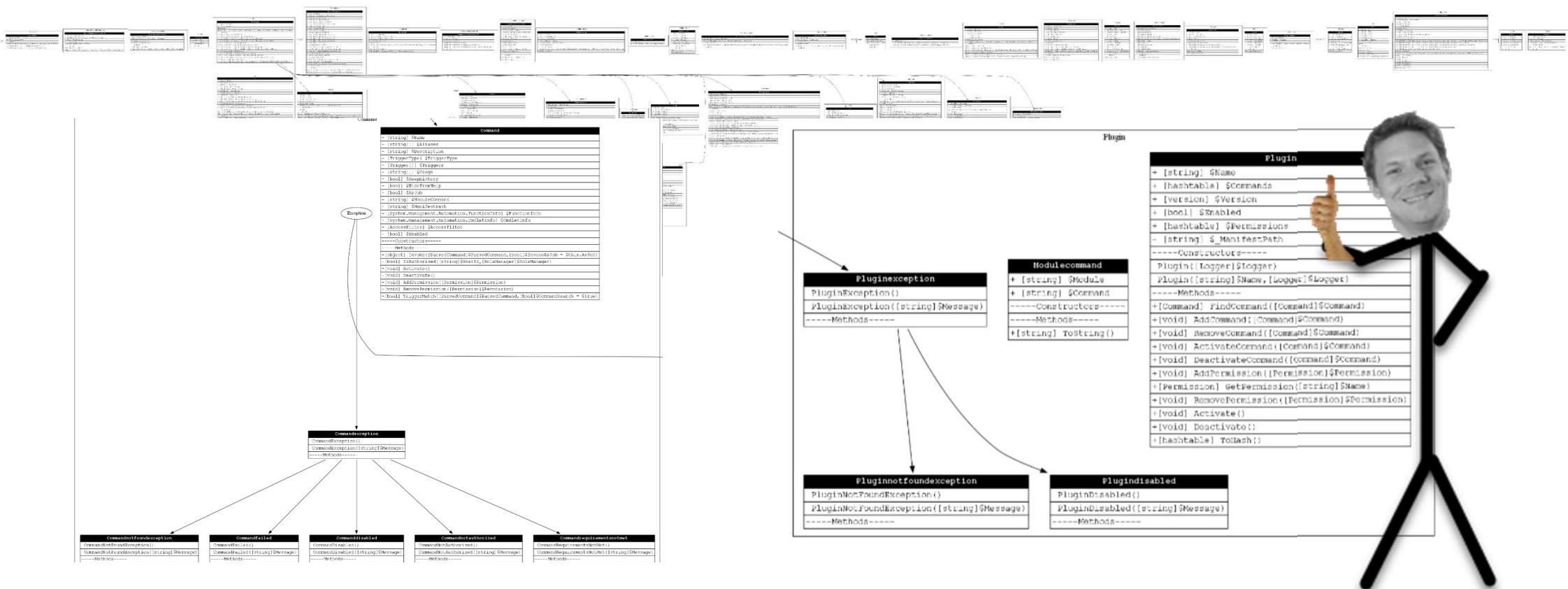
<https://github.com/PowerShell/Polaris>



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PoshBot -

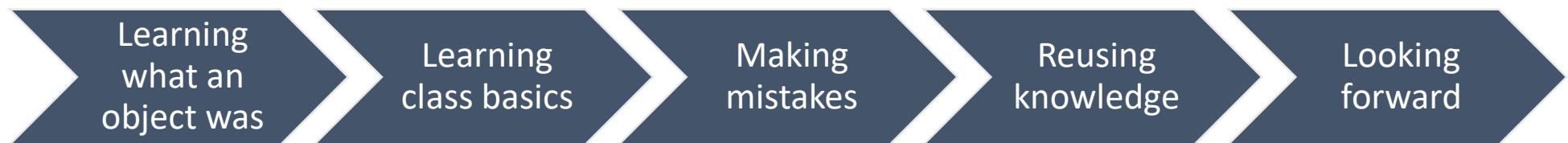
Yep...



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Plan:



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Chill:



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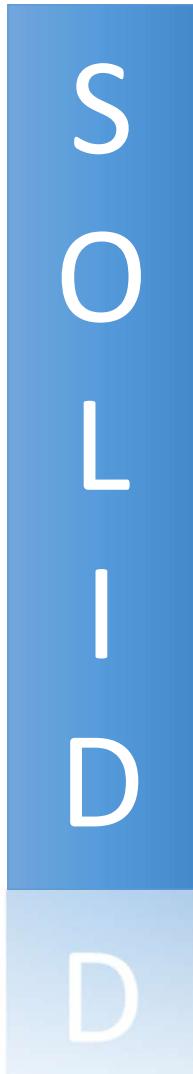


Use well known standards:

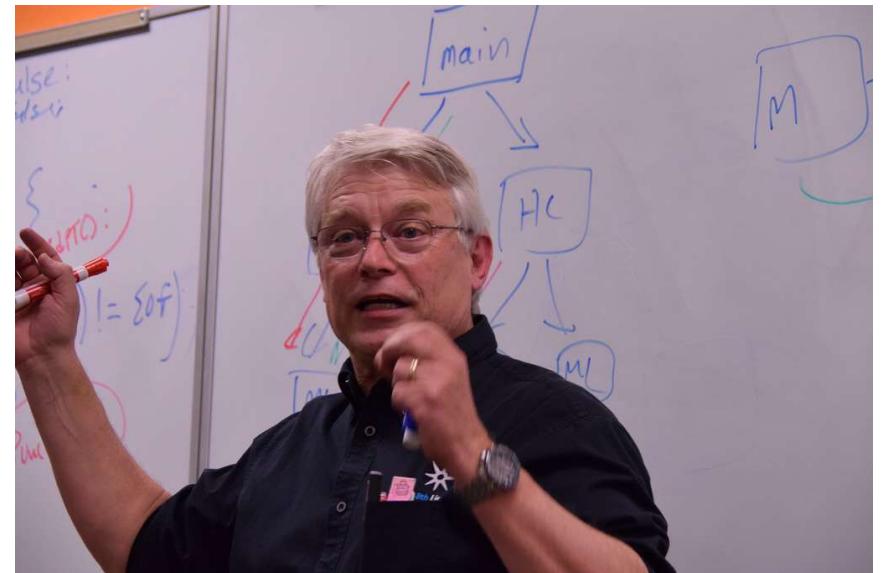
SOLID

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Use well known standards:



Robert C. Martin (Aka – Uncle Bob)



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Use well known standards:

S
O
L
I
D
D

Single responsibility principle

One class / method must have
only one responsibility



Use well known standards:

S
O
L
I
D

Open Closed Principle

Open for extension

But

Closed for modification



Use well known standards:

S
O
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Liskov substitution principle

Ability to replace any instance of a parent class with an instance of one of its child classes without side effects



Use well known standards:

S
O
L
I
D

Interface segregation principle

Write a lot of small interfaces instead of one huge interface

A class should not be forced to depend on methods it doesn't use



Use well known standards:

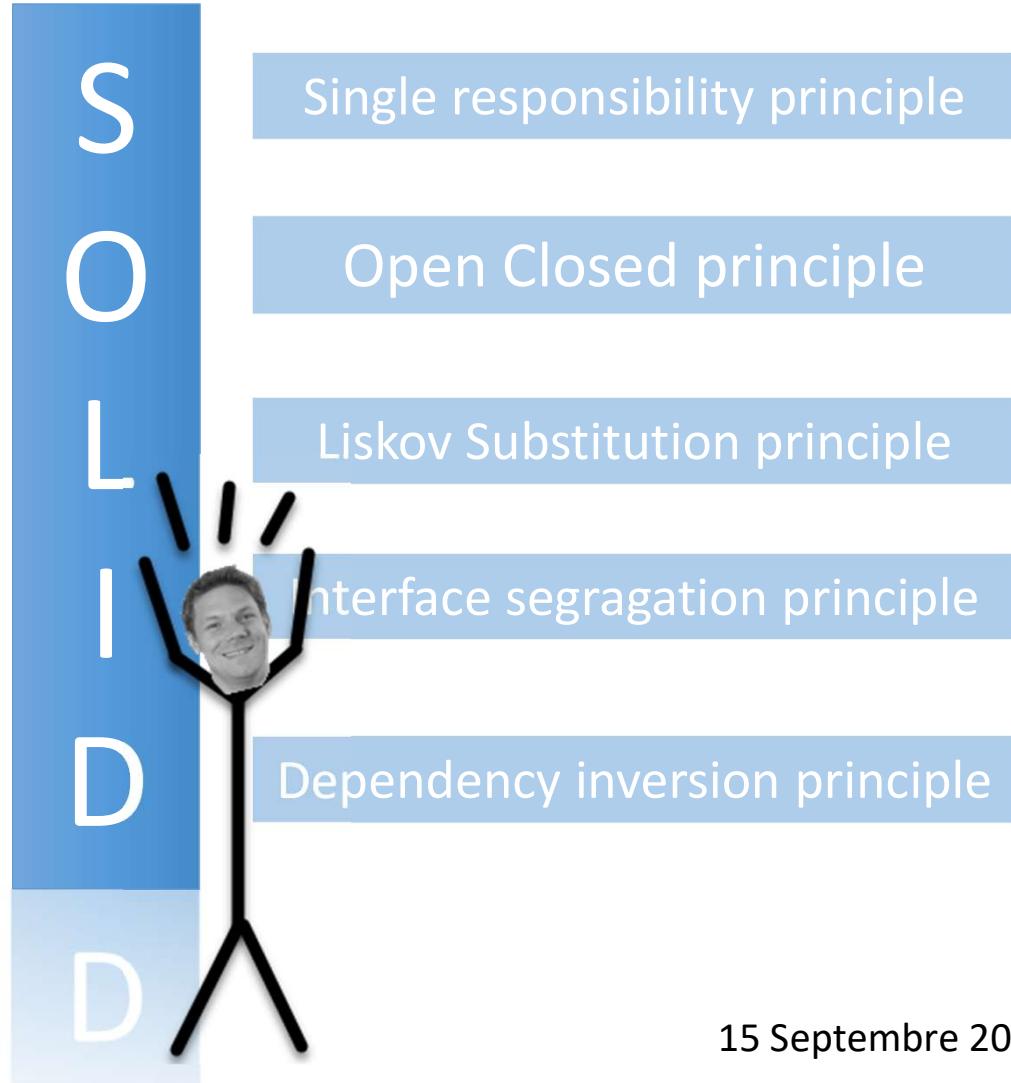
S
O
L
I
D

Dependency inversion principle

High level Modules should not depend on
low level implementations

The ActiveDirectory Module should depend
on your script to work.
The ActiveDirectory Module should not
depend on your script

Use well known standards:



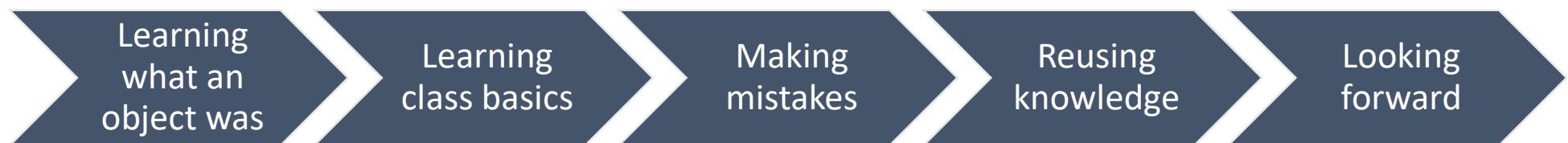


New Concepts

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Plan:



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Use well known standards:

TDD

Test Driven Developement

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Test Driven Development:

Concepts

You are **NOT allowed** to write
production code that **DOESN'T**
has a test.

Write a test, and make it fail

Write **ONLY** enough *production code* to make the **test pass**.

Write a test, and make it fail

1

2

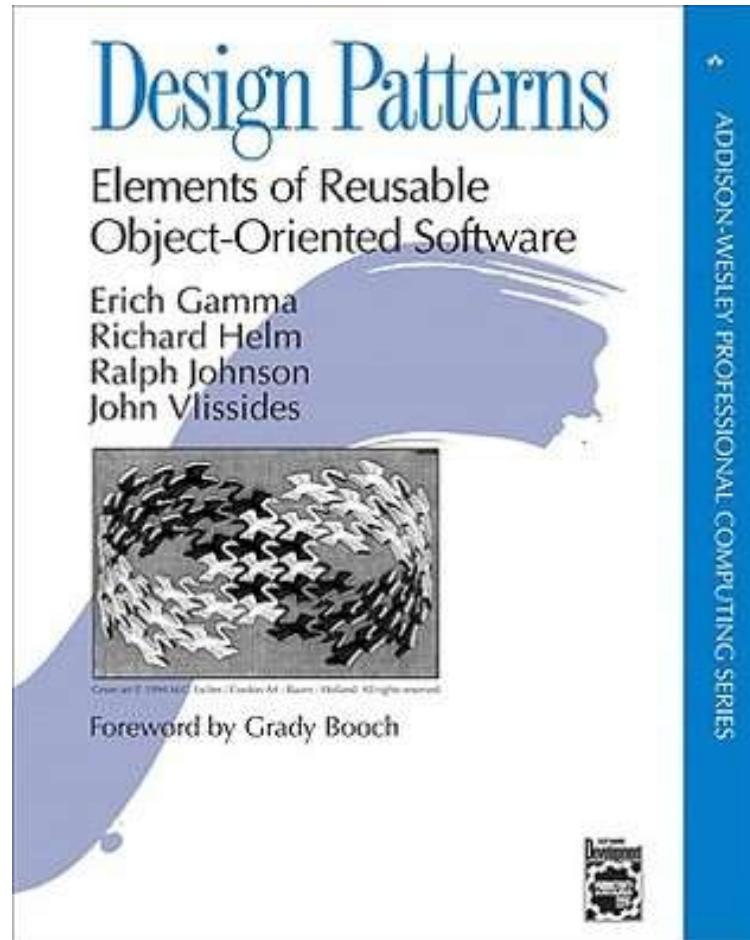
3

3



Design patterns

Gang of four



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Design pattern: Example

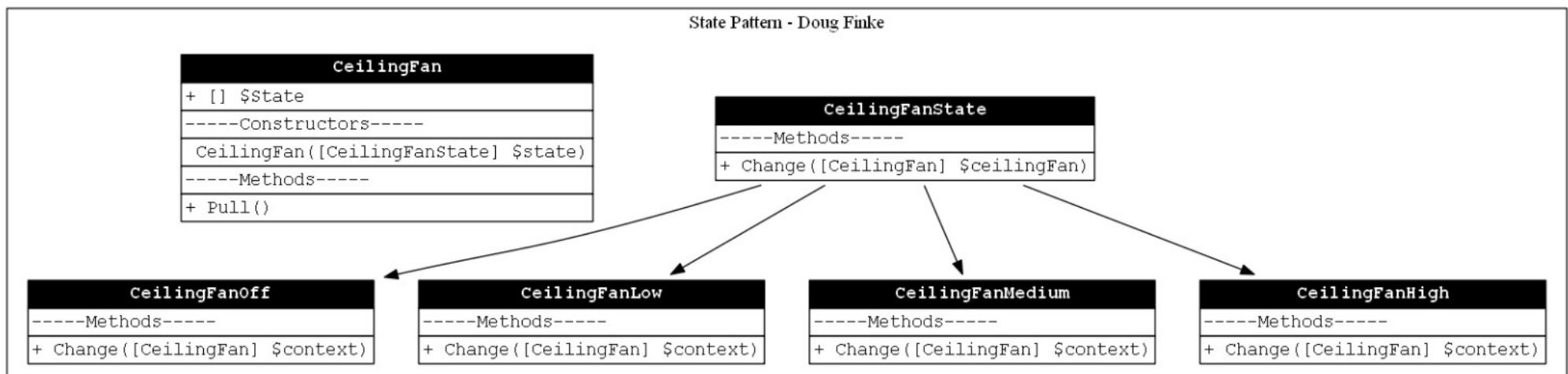
State Pattern



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Design pattern: Example

State Pattern





Design pattern: Example

State Pattern

```
class CeilingFanState {
    Change([CeilingFan] $ceilingFan) {
        throw "not implemented"
    }
}

class CeilingFanLow: CeilingFanState {
    Change([CeilingFan] $context) {
        $context.State = [CeilingFanMedium]::new()
        "Change state from Low to Medium." | Out-Host
    }
}

class CeilingFanHigh: CeilingFanState {
    Change([CeilingFan] $context) {
        $context.State = [CeilingFanLow]::new()
        "Change state from High to Off." | Out-Host
    }
}

class CeilingFanMedium: CeilingFanState {
    Change([CeilingFan] $context) {
        $context.State = [CeilingFanHigh]::new()
        "Change state from Medium to High." | Out-Host
    }
}

class CeilingFanOff : CeilingFanState {
    Change([CeilingFan] $context) {
        $context.State = [CeilingFanLow]::new()
        "Change state from Off to Low." | Out-Host
    }
}
```



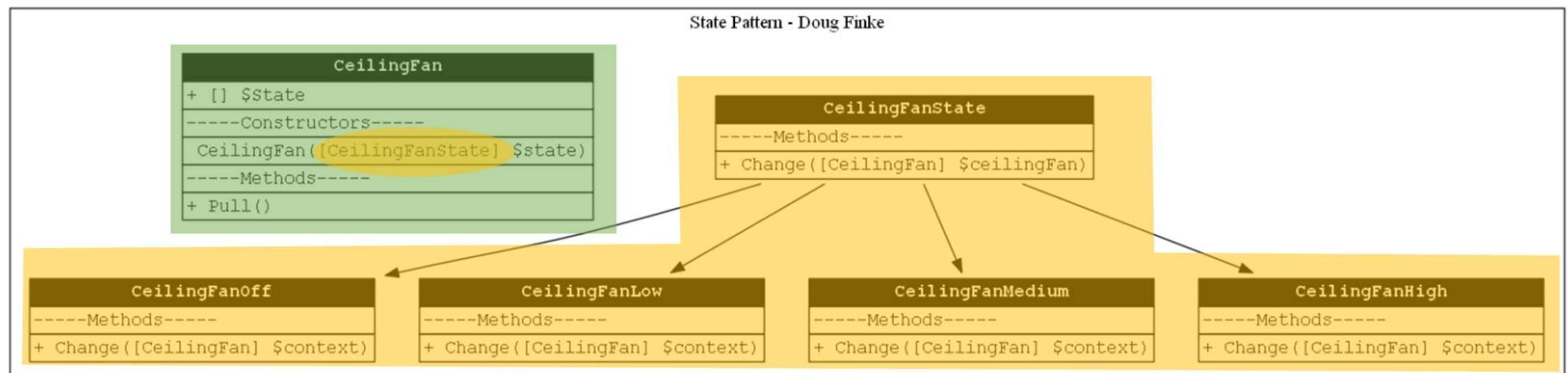
Design pattern: Example

State Pattern

```
59  $ceilingFan.Pull()  
class CeilingFa 60  $ceilingFan.Pull()  
[CeilingFan 61  $ceilingFan.Pull()  
62  $ceilingFan.Pull()  
  
CeilingFan PROBLEMS 3 OUTPUT DEBUG CONSOLE s.State = $state }  
Pull() { $t Change state from Off to Low.  
}  
Change state from Low to Medium.  
Change state from Medium to High.  
Change state from High to Off.  
  
$ceilingFan = [CeilingFan]::new([CeilingFanOff]::new())
```

Design pattern: Example

State Pattern



Design pattern: Key take aways

State Pattern

- Used different classes to express the notion of 'State'
- Each class is (represents) a specific state, with it's own behaviour
- Used inheritance
- Used Polymorphism

State Pattern

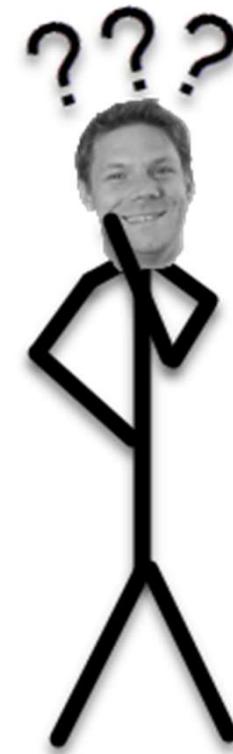
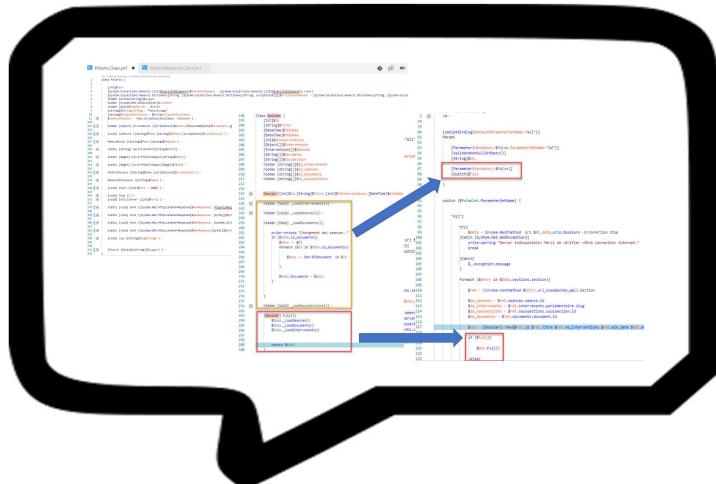
Standard Answer to a common / Well known problem

Reusable design

Reusable Code



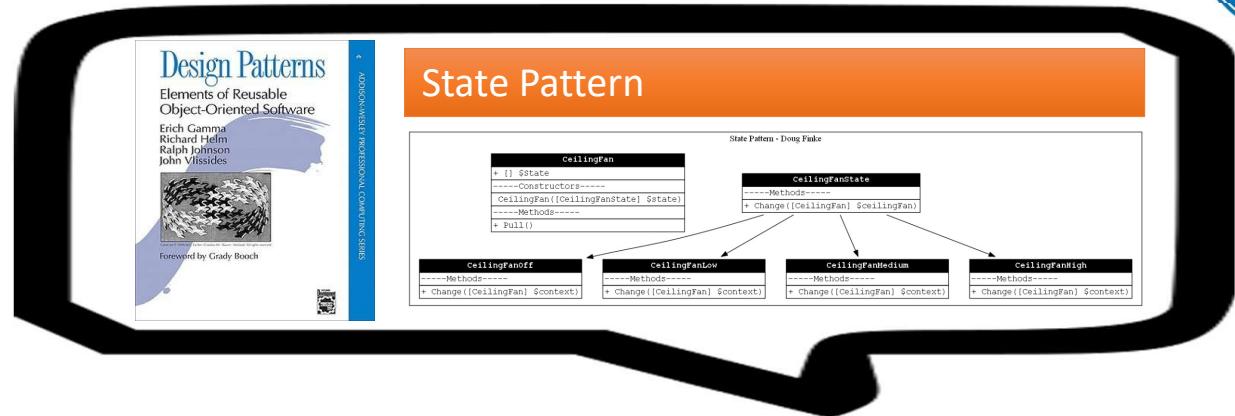
Design pattern: Key take aways



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Design pattern: Key take aways



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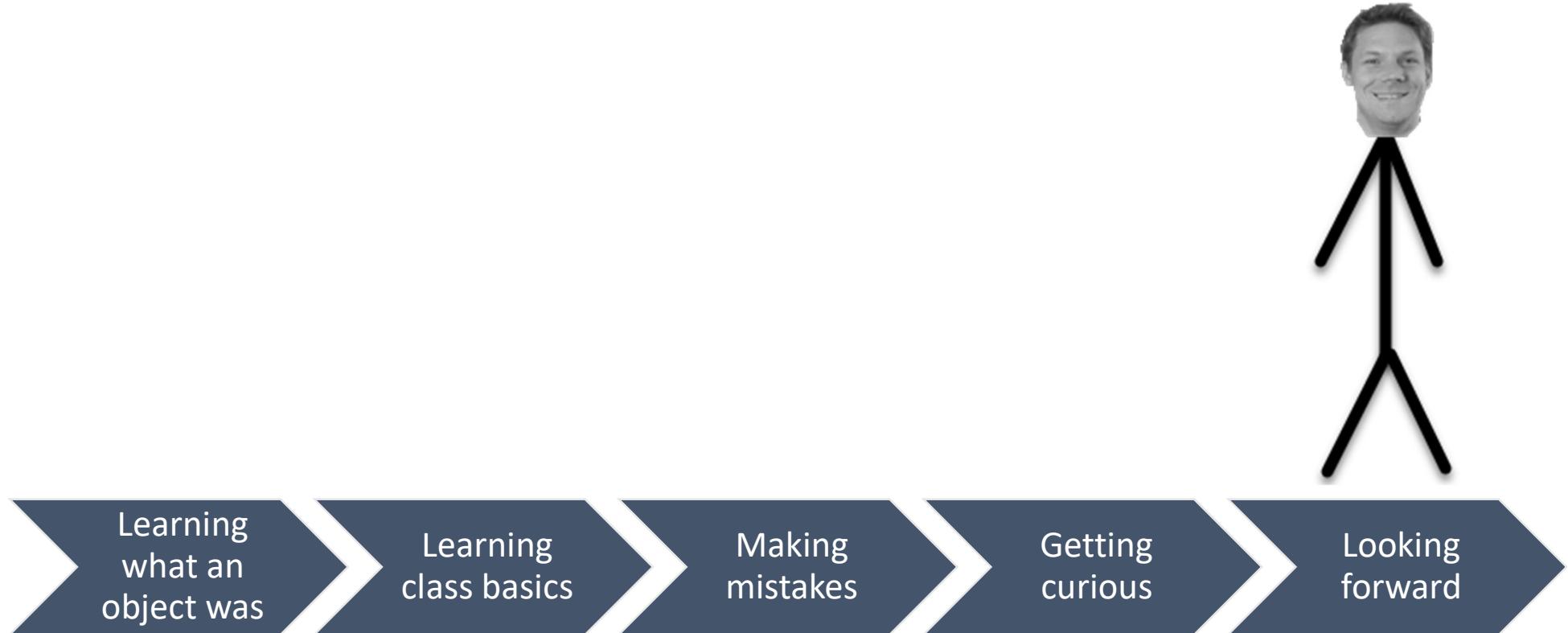


(My) Next step(s)

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Plan:



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Use well known standards:

TDD

Test Driven Developement

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Design patterns:



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Design patterns:

Creation Design Patterns

Singleton Pattern

Factory Pattern

Abstract factory

Builder Pattern

Prototype Pattern

Structural Design Patterns

Adapter Pattern

Compositie Pattern

Proxy Pattern

Flyweight Pattern

Facade Pattern

Bridge Pattern

Decorator Pattern

Behavioral Design Patterns

State Pattern

Observer Pattern

Strategy Pattern

Iterator Pattern

Visitor Pattern

Template Method

Mediator Pattern

Command Pattern

Interpreter Pattern

Memento Pattern

Chain of responsibility pattern

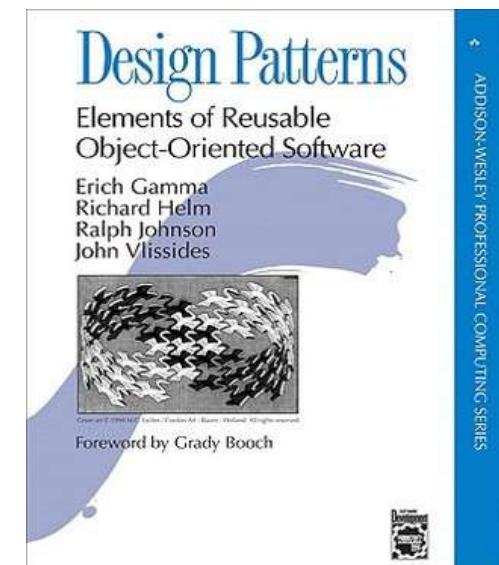


Books I (really) recommend



<https://www.amazon.fr/First-Design-Patterns-Elisabeth-Freeman/dp/0596007124>

<https://www.amazon.fr/Design-Patterns-Elements-Reusable-Object-Oriented/dp/0201633612>

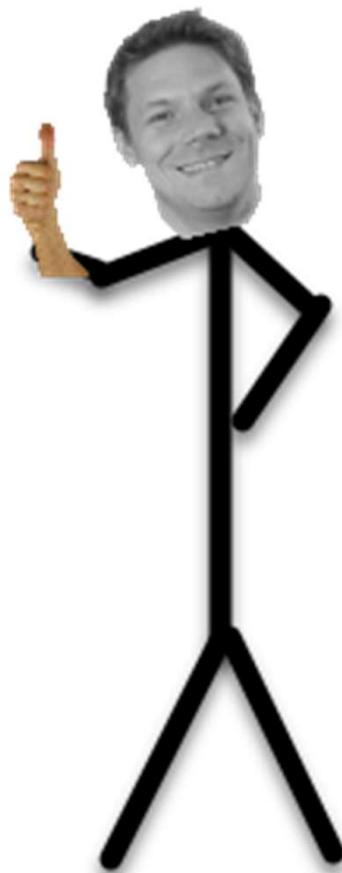




What do you see?

A bridge!

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French PowerShell Saturday

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