CATIA V5 scripting with python and Win32API

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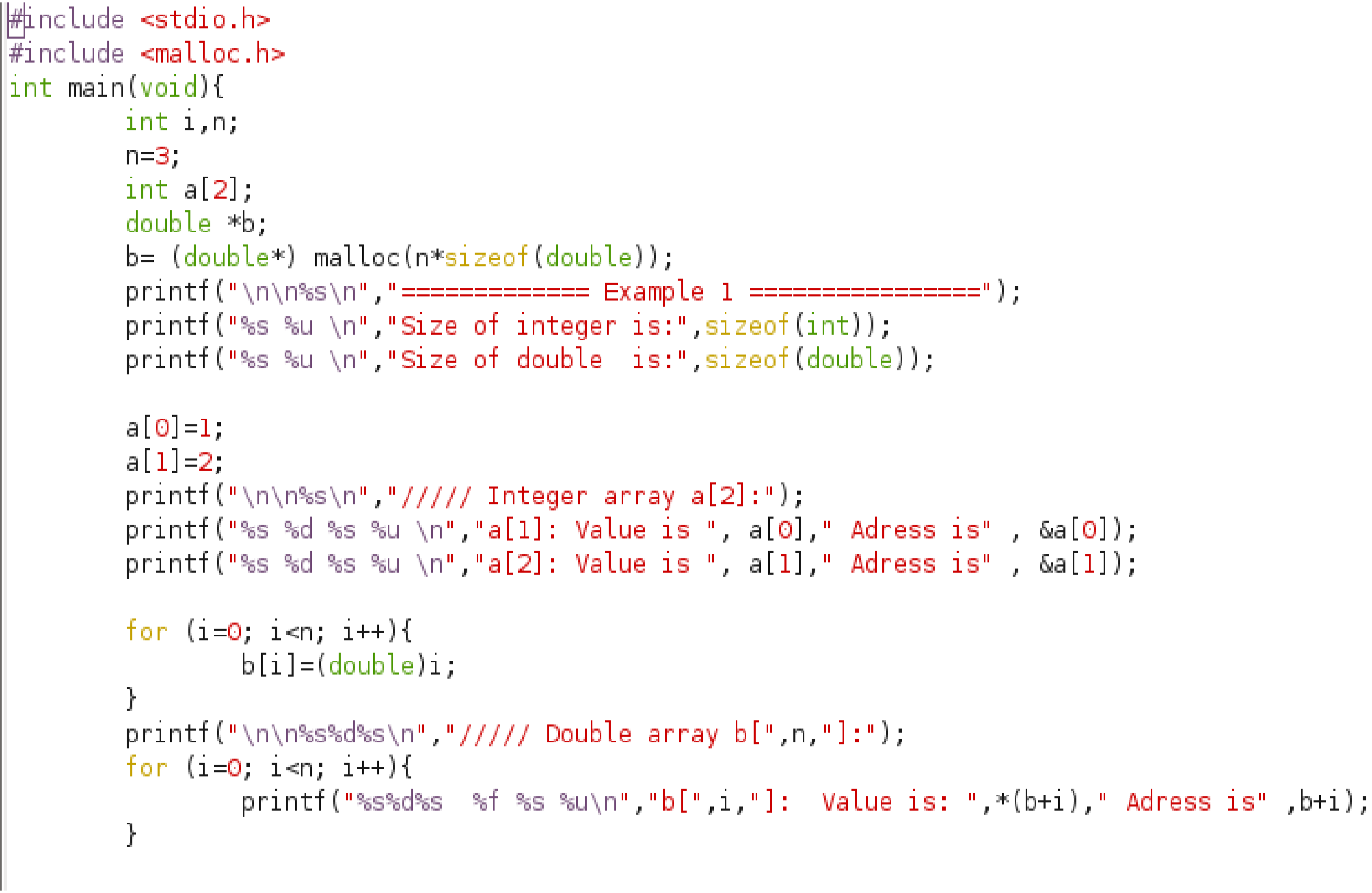
Short introduction for non-programmers

Variable:

- stores numbers, characters,strings, objects..
- variable = address of an object in computer memory

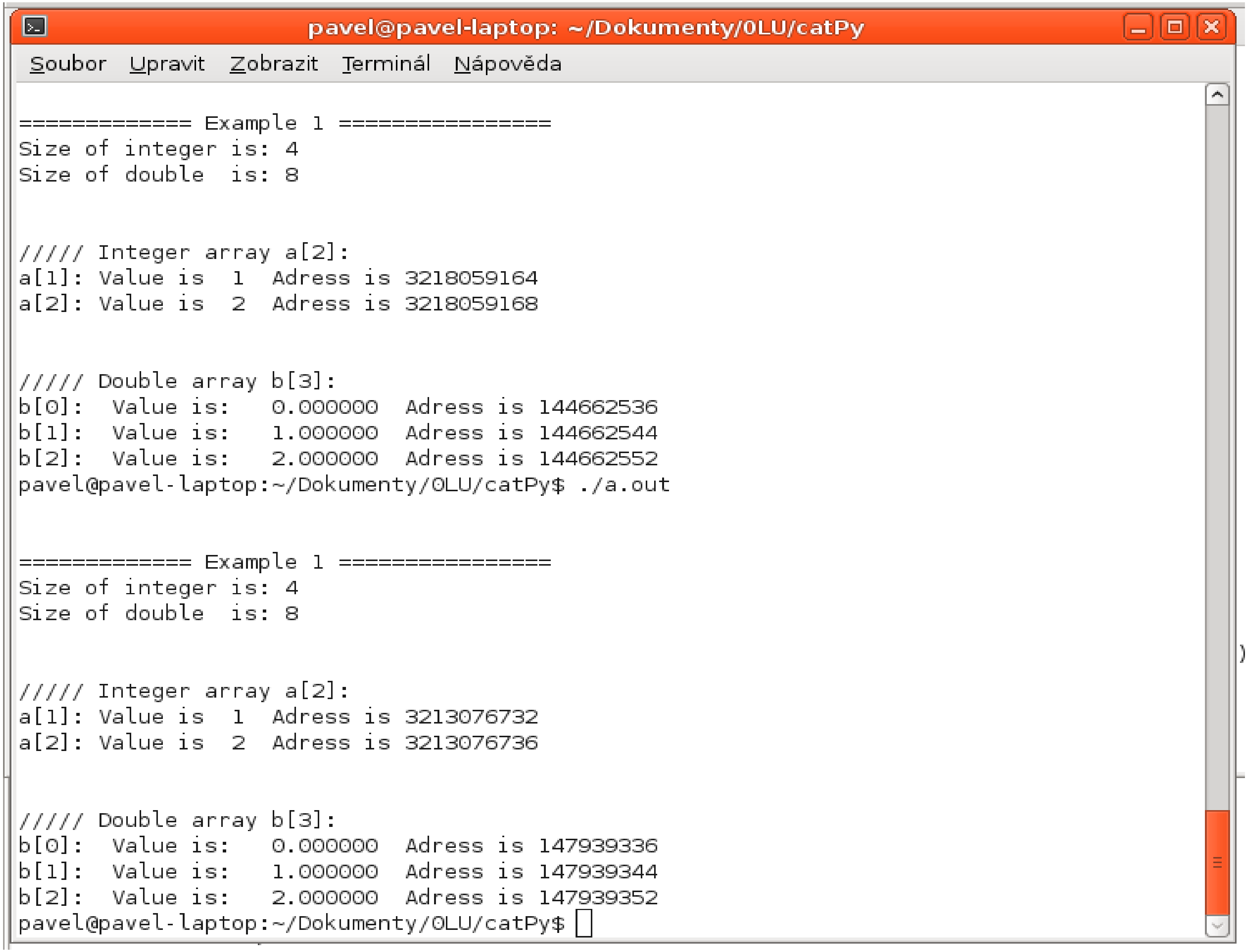


```
#include <stdio.h>
#include <malloc.h>
int main(void){
        int i,n;
        n=3;
        int a[2];
        double *b;
        b= (double*) malloc(n*sizeof(double));
        printf("\n\n%s\n","============= Example 1 ================");
        printf("%s %u \n","Size of integer is:",sizeof(int));
        printf("%s %u \n","Size of double  is:",sizeof(double));

        a[0]=1;
        a[1]=2;
        printf("\n\n%s\n","///// Integer array a[2]:");
        printf("%s %d %s %u \n","a[1]: Value is ", a[0]," Adress is" , &a[0]);
        printf("%s %d %s %u \n","a[2]: Value is ", a[1]," Adress is" , &a[1]);

        for (i=0; i<n; i++){
                b[i]=(double)i;
        }
        printf("\n\n%s%d%s\n","///// Double array b[",n,"]:");
        for (i=0; i<n; i++){
                printf("%s%d%s  %f %s %u\n","b[",i,"]:  Value is: ",*(b+i)," Adress is" ,b+i);
        }
```

Short introduction for non-programmers

Variable:

- address is managed by the operating system / program environment
Reference: C PROGRAMMING LANGUAGE, Kerninghan, Ritchie



pavel@pavel-laptop: ~/Dokumenty/0LU/catPy
Soubor Upravit Zobrazit Terminál Nápověda

```

============= Example 1 ================
Size of integer is: 4
Size of double  is: 8


///// Integer array a[2]:
a[1]: Value is  1  Adress is 3218059164
a[2]: Value is  2  Adress is 3218059168


///// Double array b[3]:
b[0]:  Value is:   0.000000  Adress is 144662536
b[1]:  Value is:   1.000000  Adress is 144662544
b[2]:  Value is:   2.000000  Adress is 144662552
pavel@pavel-laptop:~/Dokumenty/0LU/catPy$ ./a.out


============= Example 1 ================
Size of integer is: 4
Size of double  is: 8


///// Integer array a[2]:
a[1]: Value is  1  Adress is 3213076732
a[2]: Value is  2  Adress is 3213076736


///// Double array b[3]:
b[0]:  Value is:   0.000000  Adress is 147939336
b[1]:  Value is:   1.000000  Adress is 147939344
b[2]:  Value is:   2.000000  Adress is 147939352
pavel@pavel-laptop:~/Dokumenty/0LU/catPy$ 
```

Short introduction for non-programmers

Structures:

- A lot of variables makes program bad readable for humans
- This usually leads to errors, prolongs program development, …

Solution is called data structures:

- Data with common denominator are grouped together

- dot convention is used:

```
   Parent.child=something
```

Example in GNU/octave, MATLAB:

```
Aircraft=struct()
Wing=struct()
Wing.parameters=struct()

 Wing.parameters.span=10.0
 Wing.parameters.rootChord=0.9
 Wing.parameters.tipChord=0.35
 Wing.parameters.airfoil = „NACA 2412“

 Aircraft.wing=Wing
```

Short introduction for non-programmers

Functions:

- A lot of lines makes program bad readable for humans
- This usually leads to errors, prolongs program development, …

Solution is called functions:
- Repeated calculations are done by functions

```
   returnValue=function(input1,..inputN)
```

Example in GNU/octave, MATLAB:

```
function m=getVectorMagnitude(v)
   m=( v(1)^2 + v(2)^2 + v(3)^2 )^0.5;
end


a=[1,0,0]
vm=getVectorMagnitude(a)
```

Short introduction for non-programmers

Objects:

- Contains data and functions
- Functions are called “methods“
- Object is an instance of an class
- Class is a template, which defines the methods and how the data are stored
- Dot convention is usulally used:

```
object.data=something

something=Object.method(input1,..inputN)
```

Short introduction for non-programmers

Python:

- free and open source software

- a general-purpose, high-level programming language

- multi-paradigm programming language, intended to be a highly readable

- large standard library, providing pre-written tools suited to many tasks
  NumPy + SciPy can easily replace Matlab, except toolboxes.

- mainly used as a scripting language, but Python code can be packaged into
  standalone executable programs.

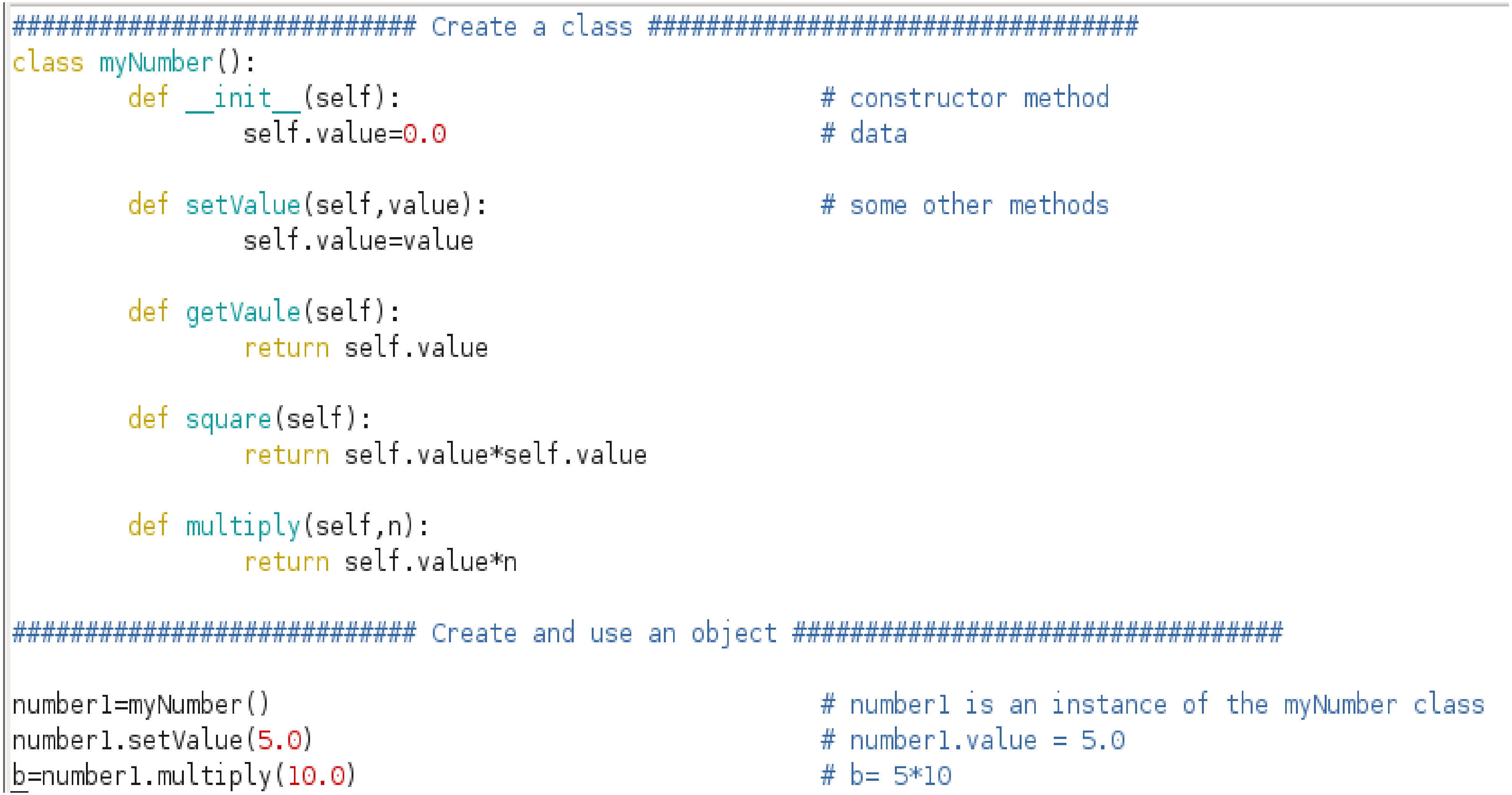
- interpreters are available for many operating systems.

- uses whitespace indentation, rather than braces or keywords, to delimit blocks

Short introduction for non-programmers

Objects:

- An example in python:
  source code:

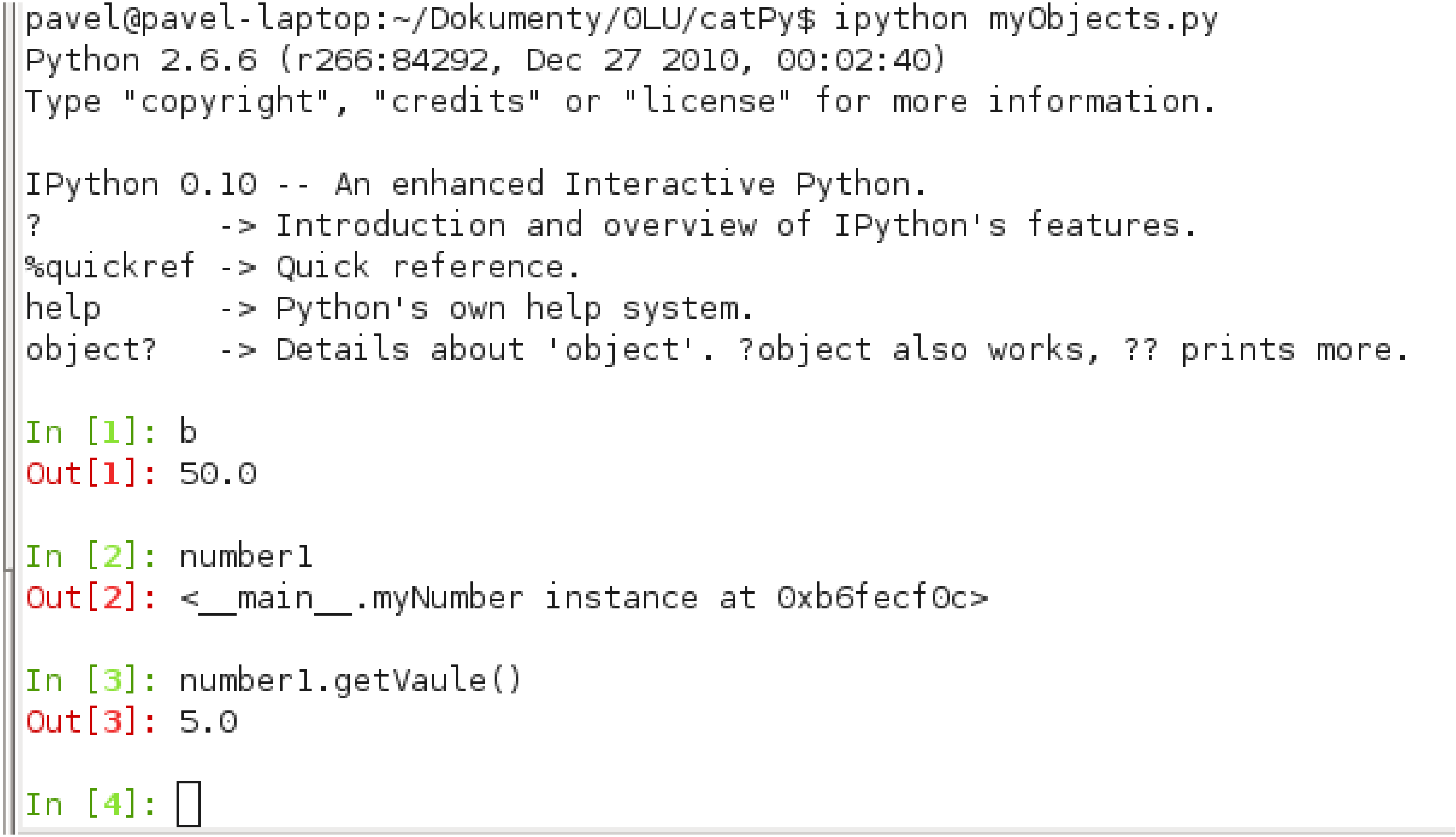


```
############################ Create a class ##################################
class myNumber():
        def __init__(self):                             # constructor method
                self.value=0.0                          # data

        def setValue(self,value):                       # some other methods
                self.value=value

        def getVaule(self):
                return self.value

        def square(self):
                return self.value*self.value

        def multiply(self,n):
                return self.value*n

############################ Create and use an object ##################################

number1=myNumber()                                      # number1 is an instance of the myNumber class
number1.setValue(5.0)                                   # number1.value = 5.0
b=number1.multiply(10.0)                                # b= 5*10
```

Short introduction for non-programmers

Objects:

- An example in python:
  program run:



```
pavel@pavel-laptop:~/Dokumenty/OLU/catPy$ ipython myObjects.py
Python 2.6.6 (r266:84292, Dec 27 2010, 00:02:40)
Type "copyright", "credits" or "license" for more information.

IPython 0.10 -- An enhanced Interactive Python.
?         -> Introduction and overview of IPython's features.
%quickref -> Quick reference.
help      -> Python's own help system.
object?   -> Details about 'object'. ?object also works, ?? prints more.

In [1]: b
Out[1]: 50.0

In [2]: number1
Out[2]: <__main__.myNumber instance at 0xb6fecf0c>

In [3]: number1.getVaule()
Out[3]: 5.0

In [4]: 
```

Scripting the CATIA V5

Requirements:

- MS Windows operating system
- Access to WindowsAPI
- CATIA V5, V6
- Text editor, not Word, Notepad

WindowsAPI:

- API = Application Programming Interface
- Collection of objects, which can be used by programmer

- Examples:

  Program can run another program by calling WinAPI

  Windows dialog boxes are usually created by calling the WinAPI

  Programs can interact each other using the WinAPI + COM

Scripting the CATIA V5

COM:

- Component Object Model
- Microsoft technology for inter-process communication
- Programs can create new objects or modify existing objects in other programs.

Example:

Spell check is used in word processor and in e-mail application.

Instead of creating two spell checks, only spell check in the word-processor is created.

If there is a need for e-mail spell checking, the spell check object from the word processor is called via WinAPI.

The binary interface, which allows this ability is called COM

- Interacting programs can be written in different languages.
- Common thing is the same object in all programs.

Scripting the CATIA V5

Strategy for working with CATIA from script:

- The strategy for working with CATIA from the script is same as the strategy for working with CATIA using the GUI.

- COM objects require same inputs as the user fills in GUI forms.

- However the task is more complex, for example naming objects in CATIA bodies may be necessary for using references.

What to do? Getting help:

- CATIA has build-in VB engine, which can record macros:

```
menu -> Tools -> Macro -> Start recording
```

- Reading recorded macros is fast method for understanding, what is all that about, but recorded macros can be filled with ballast stuff.

- Help is available:

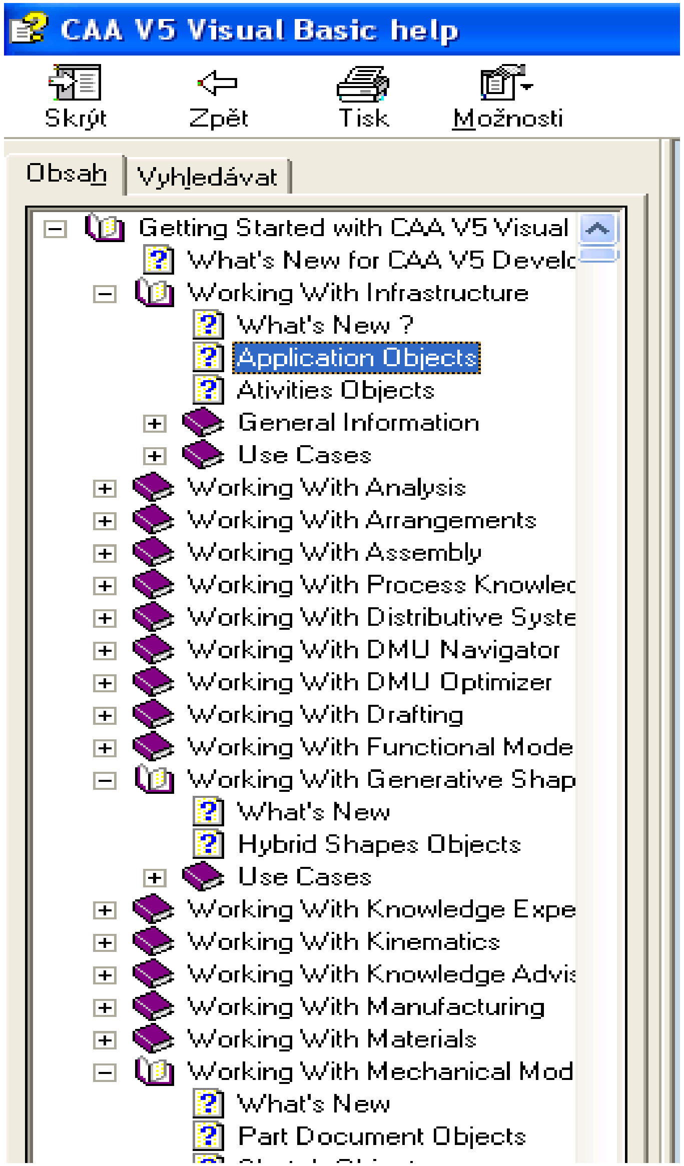
```
Dassault Systemes/B19/intel_a/code/bin/V5Automation.chm
```

Scripting the CATIA V5

V5Automation.chm

- READ IT BEFORE writing your scripts!

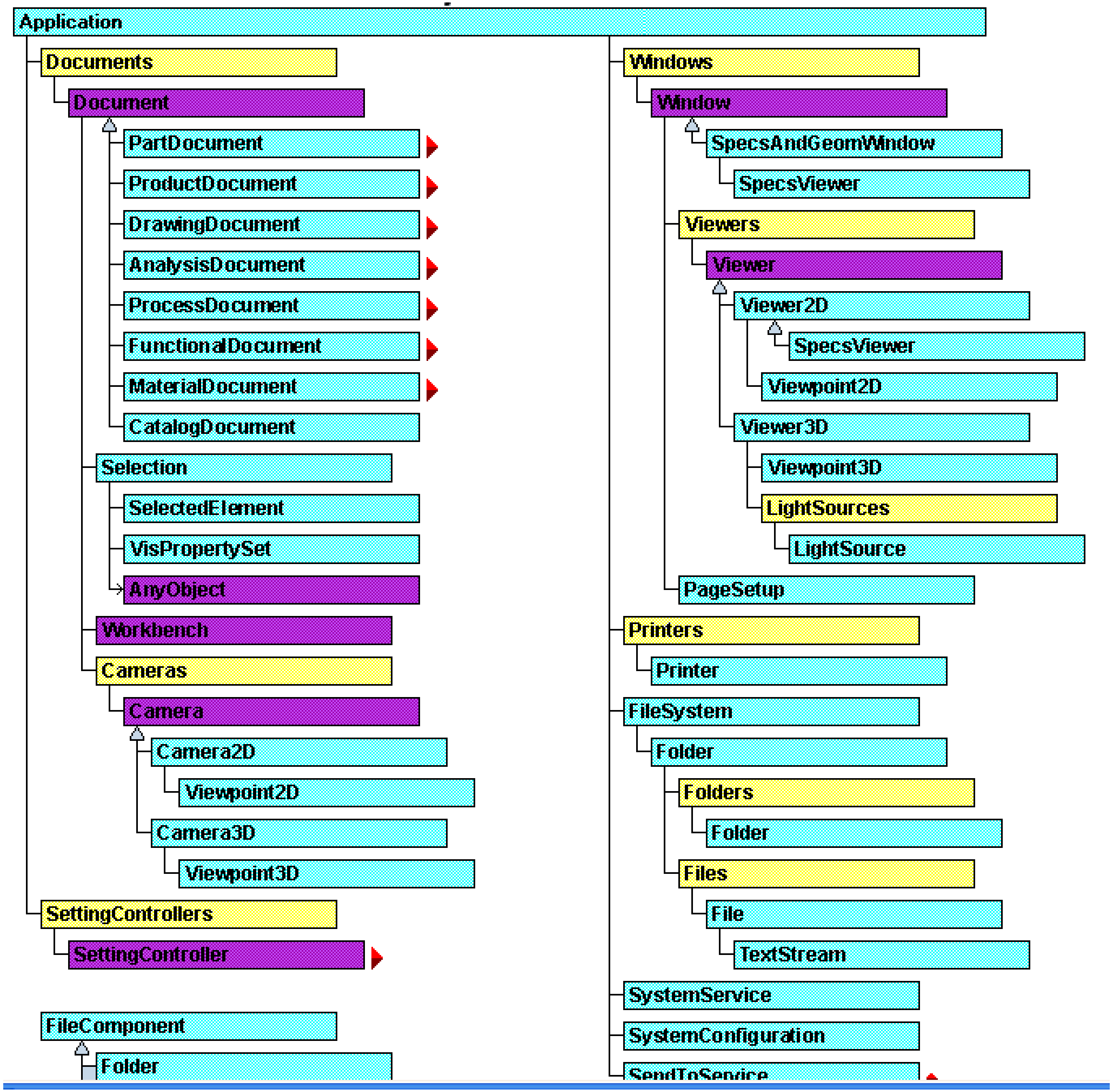
Description of CATIA objects:



CAA V5 Visual Basic help

- Getting Started with CAA V5 Visual
  - What's New for CAA V5 Develo
  - Working With Infrastructure
    - What's New ?
    - Application Objects
    - Ativities Objects
    - General Information
    - Use Cases
  - Working With Analysis
  - Working With Arrangements
  - Working With Assembly
  - Working With Process Knowlec
  - Working With Distributive Syste
  - Working With DMU Navigator
  - Working With DMU Optimizer
  - Working With Drafting
  - Working With Functional Mode
  - Working With Generative Shap
    - What's New
    - Hybrid Shapes Objects
    - Use Cases
  - Working With Knowledge Expe
  - Working With Kinematics
  - Working With Knowledge Advis
  - Working With Manufacturing
  - Working With Materials
  - Working With Mechanical Mod
    - What's New
    - Part Document Objects

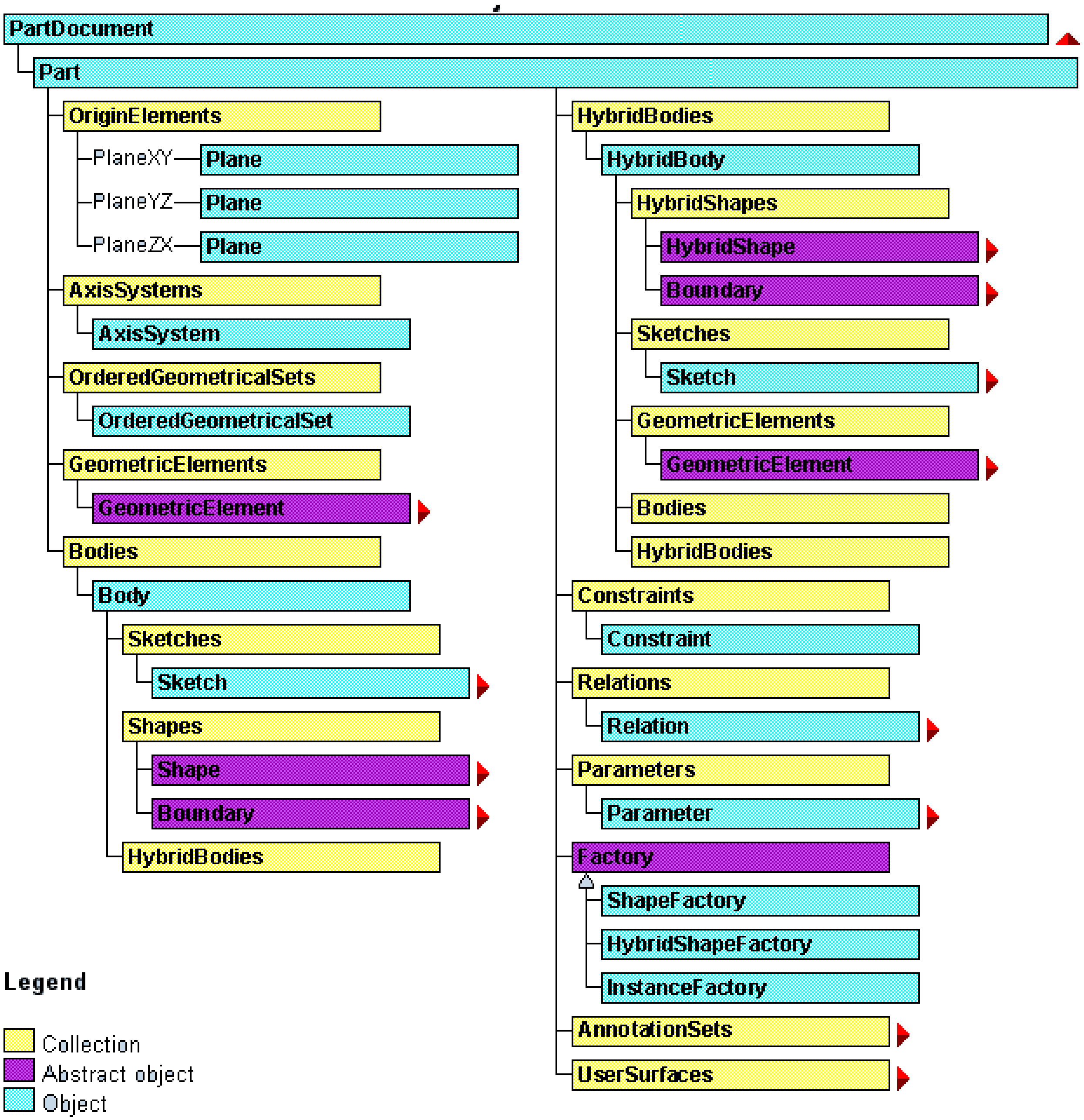
Infrastructure Automation Objects:



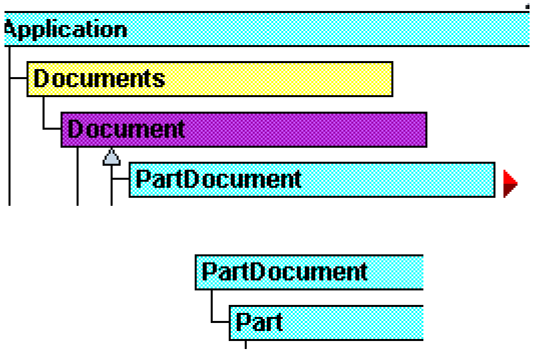
Legend

🟨 Collection
🟪 Abstract object
🟦 Object

Part Document Objects:

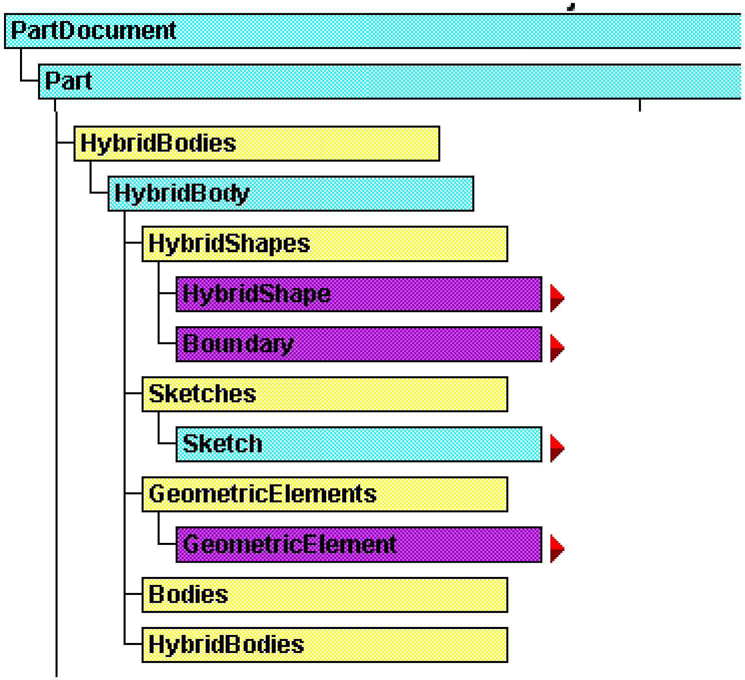


Creating new part



```
# Binding python session into CATIA
import win32com.client.dynamic    # Module for COM-Client
CATIA = win32com.client.Dispatch("CATIA.Application")

# CATIA object for managing documents
documents1 = CATIA.Documents

# Starting new part
partDocument1 = documents1.Add("Part")
part1 = partDocument1.Part
```

Creating new body

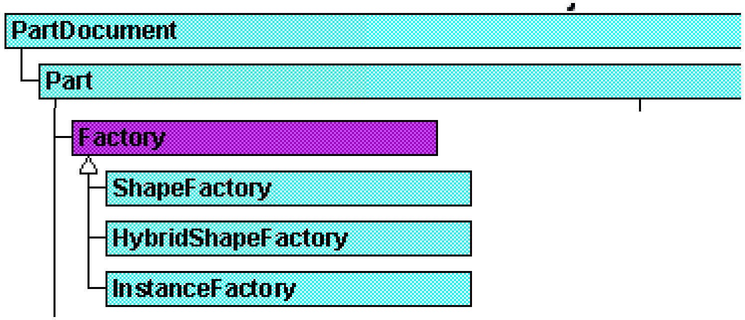


```
# Starting new body (geometrical set) in part1
bodies1 = part1.HybridBodies

# Adding new body to part1
body1 = bodies1.Add()

# Naming new body as "wireframe"
body1.Name="Wireframe"
```

Scripting the CATIA V5

Starting new shape factory

Interface to create all kinds of HybridShape objects that may be needed in wireframe and surface design.

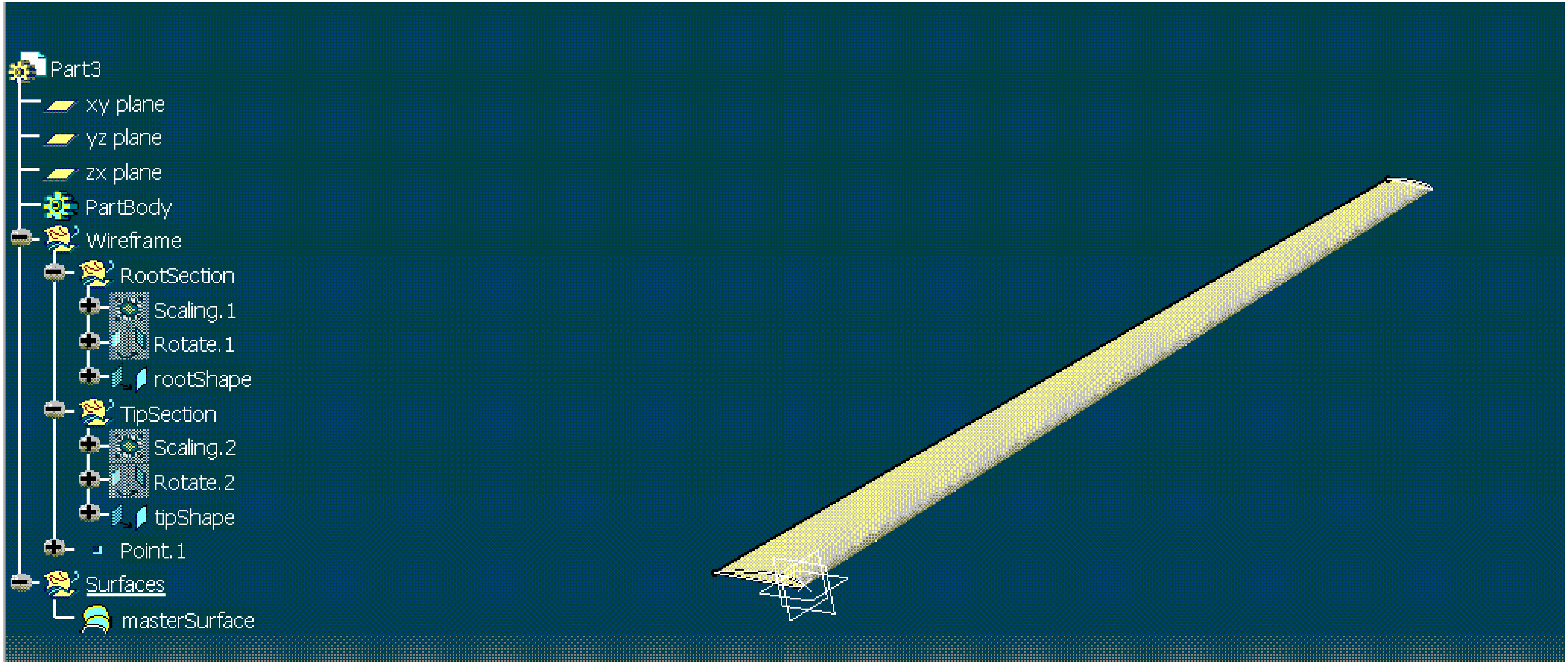


```
# Shape factory provides generating of shapes
ShFactory = part1.HybridShapeFactory
```

Using hybridShapeFactory

```
# Creating new point [0,0,0] in Wireframe
point0 = ShFactory.AddNewPointCoord(0.000000, 0.000000, 0.000000)
body1.AppendHybridShape(point0)

# part1 should be updated after every new object
part1.Update()
```

Example1: System model of tapered wing



Actions are the same as in interactive session !

Scripting the CATIA V5

Example1: System model of tapered wing

```
import win32com.client.dynamic       # Module for COM-Client
import sys, os                       # Module for File-Handling
import win32gui                      # Module for MessageBox
import numpy as np                   # Module for numerical computing

# Some basic geometrical data
halfSpan=1000.0
rootLength=100.0
tipLength=50.0
rootTwist=0.0
tipTwist=5.0

# Binding python session into CATIA
CATIA = win32com.client.Dispatch("CATIA.Application")
documents1 = CATIA.Documents             # CATIA object for managing documents
partDocument1 = documents1.Add("Part")   # Starting new part
part1 = partDocument1.Part

#Shape factory provides generating of shapes
ShFactory = part1.HybridShapeFactory
# Starting new body (geometrical set) in part1
bodies1 = part1.HybridBodies
# Adding new body to part1
body1 = bodies1.Add()
# Naming new body as "wireframe"
body1.Name="Wireframe"
```

Example1: System model of tapered wing

```
bodies2 = body1.hybridBodies         # Starting new geometrical set in Wireframe
body2 = bodies2.Add()                # Adding new body to Wireframe
body2.Name="RootSection"             # Naming new body as "RootSection"
body3 = bodies2.Add()
body3.Name="TipSection"

body4 = bodies1.Add()                # Adding new body in part1
body4.Name="Surfaces"                # Naming new body as "Surfaces"

# Loading point coordinated from text file
RootAirfoil=np.loadtxt('data/clarky.dat',skiprows=1)
TipAirfoil=np.loadtxt('data/clarky.dat',skiprows=1)

# Creating new point [0,0,0] in Wireframe
point0 = ShFactory.AddNewPointCoord(0.000000, 0.000000, 0.000000)
body1.AppendHybridShape(point0)
# part1 should be updated after every new object
part1.Update()

#Creatinging Z-direction for translating wing sections
wingAxis1= ShFactory.AddNewDirectionByCoord(0.000000, 0.000000, 1.000000)

#Creating twist point, sections will be twisted around this point
twistPoint1=ShFactory.AddNewPointCoord(25.0,0.0,0.0)
twistRef1= part1.CreateReferenceFromObject(twistPoint1)
```

Example1: System model of tapered wing

```
#Creating Z-direction for translating wing sections
twistDir1 = ShFactory.AddNewDirectionByCoord(0.000000, 0.000000, 1.000000)
#Creating [POINT-DIRECTION] axis for twisting wing sections
twistAxis1 = ShFactory.AddNewLinePtDir(twistRef1, twistDir1, 0.000000, 20.000000,
False)

# Starting new spline for root section
spline1 = ShFactory.AddNewSpline()
spline1.SetSplineType(0)
spline1.SetClosing(0)
# Filling the spline with points
for i in range(0,len(RootAirfoil)):
    PT=RootAirfoil[i]*100     # coordinates are 0..1 which is too small for CATIA
    point=ShFactory.AddNewPointCoord(PT[0],PT[1],0.0)# coordinates are 2D, Z=0.0
    spline1.AddPoint(point)                 # new point to spline is added
ShFactory.GSMVisibility(spline1,0)          # hide the spline
```

Scripting the CATIA V5

Example1: System model of tapered wing

```
# Starting new spline for tip section
spline2 = ShFactory.AddNewSpline()
spline2.SetSplineType(0)
spline2.SetClosing(0)
# Filling the spline with points
for i in range(0,len(TipAirfoil)):
    PT=TipAirfoil[i]*100
    point=ShFactory.AddNewPointCoord(PT[0],PT[1],0.0)
    spline2.AddPoint(point)
ShFactory.GSMVisibility(spline2,0)
```

Scripting the CATIA V5

Example1: System model of tapered wing

```
#Scale [REFERENCE POINT - RATIO] the root section
ref1 = part1.CreateReferenceFromObject(spline1)
ref2 = part1.CreateReferenceFromObject(twistPoint1)
scaling1 = ShFactory.AddNewHybridScaling(ref1,ref2, rootLength/100.0)
scaling1.VolumeResult = False
body2.AppendHybridShape(scaling1)
ShFactory.GSMVisibility(scaling1,0)

#Rotate [AXIS] the root section
rotate1= ShFactory.AddNewEmptyRotate()
ref1= part1.CreateReferenceFromObject(scaling1)
ref2 = part1.CreateReferenceFromObject(twistAxis1)
rotate1.ElemToRotate = ref1
rotate1.VolumeResult = False
rotate1.RotationType = 0
rotate1.Axis = twistAxis1
rotate1.AngleValue = rootTwist
body2.AppendHybridShape(rotate1)
ShFactory.GSMVisibility(rotate1,0)
```

Example1: System model of tapered wing

```
#Translate [DIRECTION - DISTANCE] the root section
# is actually not necessary here
translate1 = ShFactory.AddNewEmptyTranslate()
ref1= part1.CreateReferenceFromObject(rotate1)
translate1.ElemToTranslate = rotate1
translate1.VectorType = 0
translate1.Direction = wingAxis1
translate1.DistanceValue = 0.00
translate1.VolumeResult = False
translate1.Name="rootShape"   # Naming result "rootShape" IMPORTANT!!!
body2.AppendHybridShape(translate1)
```

Create the tip section yourself

Scripting the CATIA V5

Example1: System model of tapered wing

```
#Create new loft - MULTISECTION SURFACE
loft1 = ShFactory.AddNewLoft()
loft1.SectionCoupling = 1
loft1.Relimitation = 1
loft1.CanonicalDetection = 2

#Adding root section to the loft
shapes1 = body2.HybridShapes
# getting item from pool!!
result1 = shapes1.Item("rootShape")
ref1 = part1.CreateReferenceFromObject(result1)
ref2 = None
loft1.AddSectionToLoft(ref1, 1, ref2)

#Adding tip section to the loft
shapes2 = body3.HybridShapes
# getting item from pool!!
result2 = shapes2.Item("tipShape")
ref1 = part1.CreateReferenceFromObject(result2)
ref2 = None
loft1.AddSectionToLoft(ref1, 1, ref2)
loft1.Name="masterSurface"

#Adding loft to Surfaces geometrical set
body4.AppendHybridShape(loft1)
part1.Update()
```