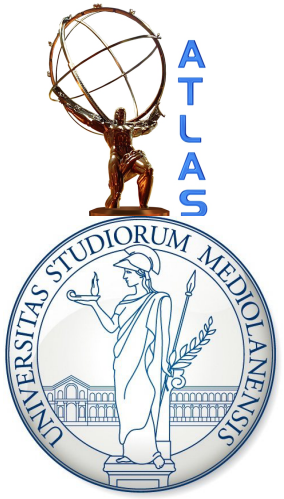

ROOT tutorial, leftovers: pyROOT

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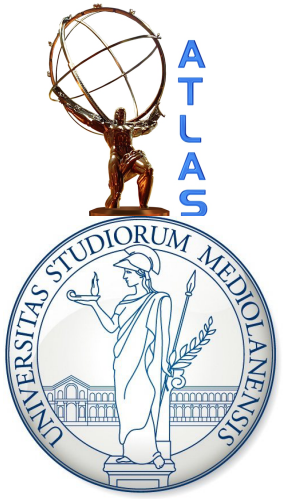
HASCO school – 18/07/2012



pyROOT

Inspiration taken from a tutorial by Daniel Short (Oxford)

Usual disclaimer:
following slides are biased
by current use of pyROOT,
here only introducing
basics needed for the hands-on

A more complete set of lectures (Glasgow)
The pyROOT tutorials in ROOT

ROOT Tutorial
HASCO school – 18/07/2012

Why PyROOT?

...to avoid worrying about types and strings!

```
TTree * t = (TTree*) myFile->Get("myTree")
```

vs

```
t=myFile->Get("myTree")
```

```
TString s = TString::Form("My string is %c of chars
      and numbers, like %d"), "made", 200)
      cout << s.Data() << endl;
```

vs

```
s = "My string is"+" made "+of chars and numbers,
      like"+str(200)
      print s
```

Python is a powerful language...

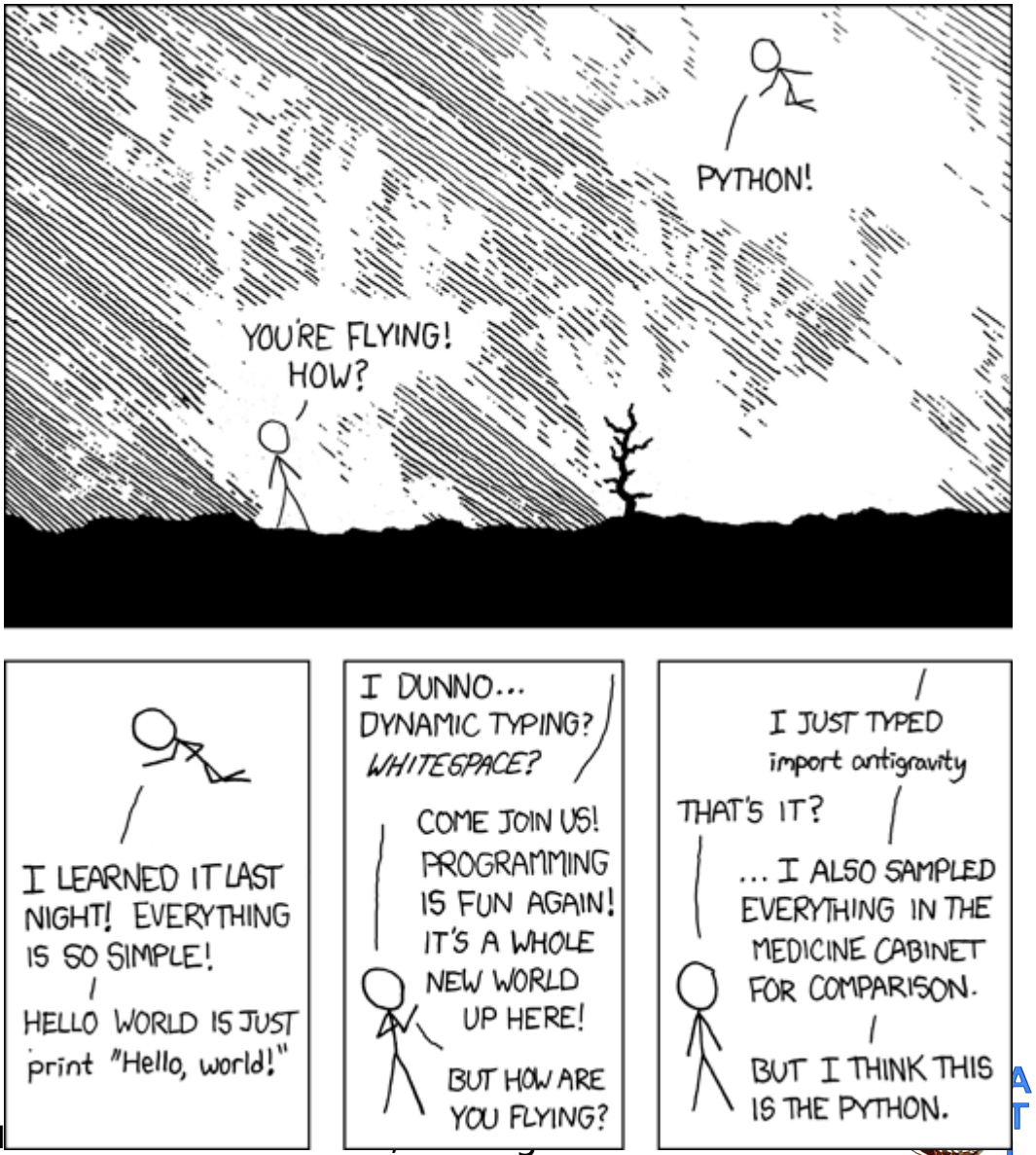
Formatting histograms in python does not do the language justice...

Python:

- High level interpreted programming language
- Object-oriented too!
- Some people write entire analyses using pyROOT and derivatives...can be done!
- We will be using it for **formatting plots**
  → advantage: ROOT macros treating data don't get polluted with string, axes renaming, colors treatment etc

Useful properties:

- Everything is a reference (no pointers...)
- Automatic garbage collection (this sometimes clashes with ROOT's...)
- Built-in help and reference listing
- Strongly typed
-



http://xkcd.com/353/

Using Python

Interactive console

```
cate@catelenovolinux:~/Work/HASCO$ python
Python 2.7.3 (default, Jun 15 2012, 15:26:07)
[GCC 4.7.0] on linux2
Type "help", "copyright", "credits" or "license" for more inform
ation.
>>> print "My hovercraft is full of eels"
My hovercraft is full of eels
```

To quit session: **CTRL-D**

Precompiled scripts

HelloPython.py

```
#/bin/python

print "my hovercraft is full of eels"
```

```
cate@catelenovolinux:~/Work/HASCO$ python HelloPython.py
my hovercraft is full of eels
```

Essential Python (1)

Python **works out variable types** while running
→ no need for declaration!

```
>>> myVariable = 5
>>> print 5
5
>>> myVariable = "Ex-parrot"
>>> print myVariable
Ex-parrot
```

Python can use external libraries and functions (=modules)

```
>>> from ROOT import TF1
>>> f=TF1("myFunction", "sin(x)/x", 0,10)
>>> f.GetName()
'myFunction'
```

First hint of pyROOT.
The *math* and *numpy* libraries are also very useful…

Python **cares about whitespace**

Need to **indent** in case of if statements/for loops…

```
#/bin/python

eels = True

if eels :
  print "my hovercraft is full of eels"
```

Essential Python by example (2)

For loops and xrange

```
>>> for i in xrange(1,10) :
...     print i
...
1
2
3
4
5
6
7
8
9
```

Dictionaries

```
>>> myDictionary = {"eggs": "delicious", "spam": "even more deli
cious"}
>>> for (key, value) in myDictionary.iteritems() :
...     print "A sandwich with", key, "is", value
...
A sandwich with eggs is delicious
A sandwich with spam is even more delicious
```

Lists

```
>>> myArray = ["eggs", "eggs", "spam", "eggs"]
>>> for myItem in myArray :
...     print myItem
...
eggs
eggs
spam
eggs
>>> len(myArray)
4
```

Functions

Sandwich.py

```
#!/bin/python

def sudomakemeasandwich() :
    print "Here's your sandwich"
    print """

       ( `^` ))
       |     ||
       |     ||
       '-----'`

    """
```

Indent!

Function name

module

```
>>> from Sandwich import sudomakemeasandwich
>>> sudomakemeasandwich()
Here's your sandwich


       ( `^` ))
       |     ||
       |     ||
       '-----'`
```

The **zip** function

```
>>> foods = ["salmon mousse", "broccoli"]
>>> properties = ["deadly", "healthy"]
>>> for food, property in zip(foods, properties) :
...     print food, "is", property
...
salmon mousse is deadly
broccoli is healthy
```


Strings in Python (1)

Building a string

```
>>> person = "A viking"
>>> place = "a bar"
>>> action = "walks"
>>> myString = person + " " + action + " into " + place
>>> print myString
A viking walks into a bar
```

Very easy!

Numbers are not strings (or: python knows what type a variable is)

```
>>> places = "bars"
>>> numberOfPlaces = 2
>>> myString = person + " " + action + " into " + numberOfPlaces
+ places
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
TypeError: cannot concatenate 'str' and 'int' objects
```

```
>>> places = "bars"
>>> numberOfPlaces = 2
>>> myString = person + " " + action + " into " + str(numberOfPl
aces) + " " + places
>>> print myString
A viking walks into 2 bars
```

A bit like casting in C++....

Strings in Python (2)

A string is an array of characters

```
>>> myString = "SpamHam"
>>> print myString[0], myString[0:4], myString[4:7]
S Spam Ham
```

Finding substrings

```
>>> myString = "SpamHam"
>>> myString.find("Spam")
0
>>> myString.find("Ham")
4
```

```
>>> print myString[myString.find("S"):4]
Spam
```

Removing parts of strings

```
>>> myString = "EggsHam"
>>> print myString.rstrip("Ham")
Eggs
>>> print myString.lstrip("Eggs")
Ham
```

Strings in Python (3)

Tokenizing a string

```
#/bin/python

line = "fSumw[0]=0, x=-12.5, error=0"

tokens = line.split(", ")

print tokens
```

```
cate@catelenovolinux:~/Work/HASCO/pyROOT$ python Tokenizer.py
['fSumw[0]=0', 'x=-12.5', 'error=0']
```

Getting a string from a text file

```
>>> mytextfile = open("data.txt","r")
>>> for line in mytextfile :
...   print line
...
 fSumw[0]=0, x=-12.5, error=0
```

Essential pyROOT (1)

Import ROOT classes as modules (can check what there is with `dir()` function)

```
>>> from ROOT import TF1
>>> dir()
['TF1', '__builtins__', '__doc__', '__name__', '__package__']
```

Tab-completion works here as well:

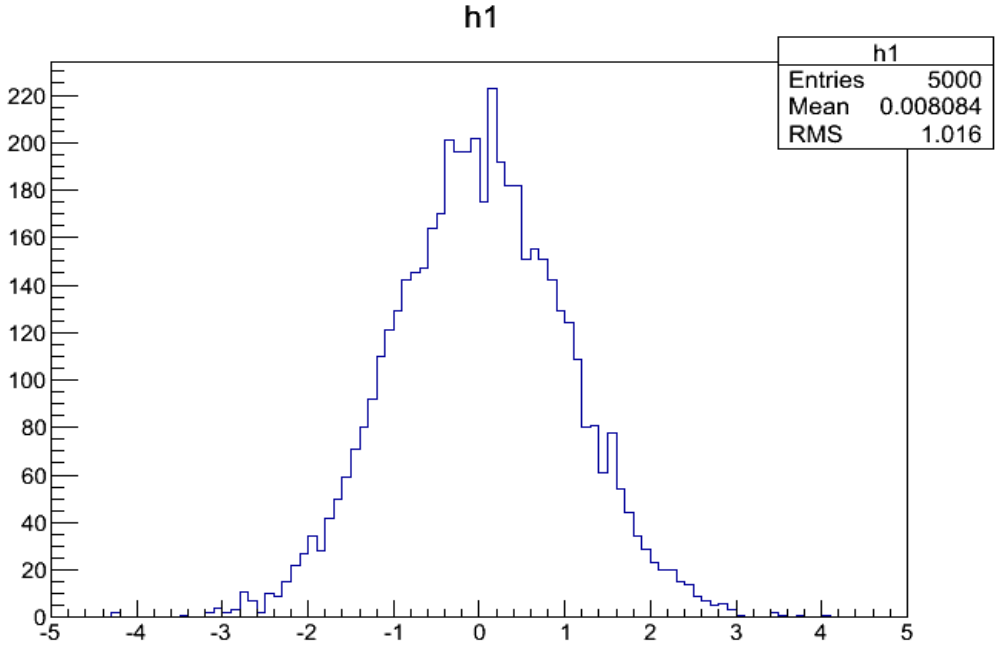
```
>>> from ROOT import Math
>>> Math.
Display all 132 possibilities? (y or n)
Math.__add__(                    Math.chisquared_cdf(
Math.__base__(                   Math.chisquared_cdf_c(
Math.__bases__                   Math.chisquared_pdf(
Math.__basicsize__               Math.chisquared_quantile(
Math.__bool__(                   Math.chisquared_quantile_c(
Math.__call__(                   Math.cosint(
Math.__class__(                  Math.erf(
```

Essential pyROOT (2)

Instantiating an object in python works slightly differently wrt C++

In general, use ROOT classes in the same way as in CINT,
without worrying about **.** Vs **→** as in python everything is a reference

```
>>> from ROOT import TH1D, TCanvas
>>> h1 = TH1D("h1", "h1", 100, -5,5);
>>> h1.FillRandom("gaus")
>>> h1.Draw()
Info_in <TCanvas::MakeDefCanvas>:  created default TCanvas with name c1
```



Reading objects out of a file

pyROOT advantage: easy use of TLists

```
#!/bin/python

from ROOT import TFile

#Note: some names are reserved in python
#instantiating another object with that name would 'overwrite' them
#--> don't call the file you're opening 'file'

myFile = TFile.Open("fillrandom.root","READ")

#GetKeyNames produces a list of the names (keys)
#of the objects contained in the file
for keyName in myFile.GetListOfKeys() :
  #we can also pick the object up for later use
  myObject = myFile.Get(keyName.GetName())
  print myObject
```

Anything that is a list can be used easily in a loop

```
cate@catelenovolinux:~/Work/HASCO$ python ReadOutOfFile.py
<ROOT.TFormula object ("form1") at 0x2f9b780>
<ROOT.TF1 object ("sqroot") at 0x2ea3f20>
<ROOT.TH1F object ("h1f") at 0x303e9c0>
```

Formatting many histograms

An example of how I use dictionaries...

```
#Dictionary holding names, (titles), colors
PlotDictionary = {
   "InSitu_LArEMscale":1,
   "Zjet_MC":2,
   "Zjet_Veto":4,
   "Zjet_JVF":kGreen-2,
   "Zjet_KTerm":kMagenta-2,
   "Zjet_Width":kOrange+2,
```

Key: something that can be easily obtained from the graph name
Value: color of that plot

```
#get the name of the component:
variationName = componentGraph.GetName().split("_")
[1]+"_"+componentGraph.GetName().split("_")[2]
plotTitle =  componentGraph.GetTitle()
markerColor = PlotDictionary[variationName]
markerStyle = 20
markerSize = 1.0

componentGraph.SetMarkerColor(markerColor)
componentGraph.SetMarkerStyle(markerStyle)
componentGraph.SetLineColor(markerColor)
componentGraph.SetLineWidth(1.4)
componentGraph.SetLineStyle(1.4)
componentGraph.SetMarkerSize(markerSize)
```

Some string magic to obtain the 'key' above

Assigning the right color from the dictionary

TGraphs

Reading out points from a TGraph

```
#graph is a TGraph from some file...

#loop on all data points
nPoints = graph.GetN()
for iPoint in xrange(0,nPoints) :
  #need to use ROOT's native Double to extract points
  dataPointX = Double(0)
  dataPointY = Double(0)
  graph.GetPoint(iPoint,dataPointX,dataPointY)
  dataErrorX = graph.GetErrorX(iPoint)
  dataErrorY = graph.GetErrorY(iPoint)
```

Creating a TGraph from ROOT arrays

```
#need to import the 'array' module
from array import array

#arguments: type (e.g. "d" = double), list
x = array("d", [1,2,3,4,5])
y = array("d", [3,2,6,3,7])

g = TGraph(len(x), x,y)
```

Better than spam sandwiches!

Thanks for the attention and
for the company!