

Improving Analysis Workflow with IPython

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January 27, 2013

Advertisement

Time and Location:

- ▶ Setup Session. 1.5 hour.
Monday Jan 28 2013 16:00-17:30 Redwood C/D.
- ▶ Tutorial Session. 4 hour.
Thursday Jan 31 2013 8:30am-12:30pm Redwood C/D.

Prepare your laptop in advance

Visit our web page for instruction. You are strongly encouraged to try to prepare your laptop before the setup session. If there is any problem, just come to Setup Session. We will try our best to help.

http://piti118.github.com/babar_python_tutorial/

Can't attend the tutorial?

The materials on the website is designed so that you learn it by yourself. They are all downloadable from our website.

What's better about Python etc.?

The Language

- ▶ A lot of problem with ROOT is not really ROOT problem.
- ▶ C++ is a very verbose static type language. Good for other things but not a dynamic work like data analysis.
- ▶ C++. Static typing. Repeat yourself like crazy.

```
TFile f("myfile.root");  
TTree* tree = dynamic_cast<TTree*>f.Get("tree");  
float x;  
▶ tree->SetBranchAddress("x",&x); //repeat this  
tree->GetEntry(10);  
cout << x << endl;
```

- ▶ Python. root_numpy.

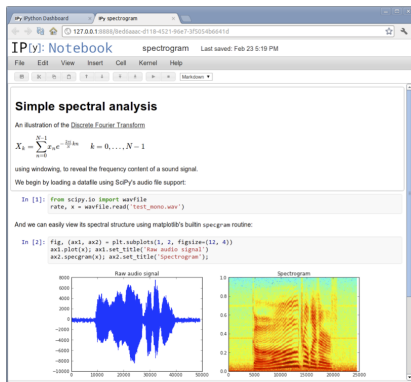
https://github.com/rootpy/root_numpy

-
- ```
data = root2rec("myfile.root")#treename is optional
▶ print data.x[10]
```
- 
- ▶ There is PyROOT. But it is very slow for doing basic stuff like reading file. root\_numpy is as fast as C++. There is also rootpy which use root\_numpy as backend.

# Interactive Environment

```
CINT/ROOT C/C++ Interpreter version 5.18.00, July 2, 2010
Type ? for help. Commands must be C++ statements.
Enclose multiple statements between { }.
root [0]
```

- ▶ ROOT interactive environment is not so good for doing analysis. Both new TBrowser and command prompt environment.
- ▶ IPython Notebook environment.
- ▶ <http://ipython.org/>
- ▶ Mathematica. Maple. Matlab. Sage.
- ▶ Type command. See output. Edit command. See output.
- ▶ Immediate inline feedback is the key. No separate windows.
- ▶ Save it along with output. Come back and view/re-execute later.
- ▶ Autocomplete. Docstring. IPython magic.
- ▶ `numpy`
  - ▶ <https://github.com/piti118/numpy>



```
mc = root2rec('SP1005_Run1.root', 'cand')
```

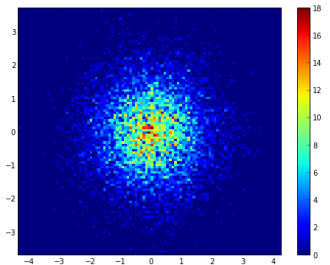
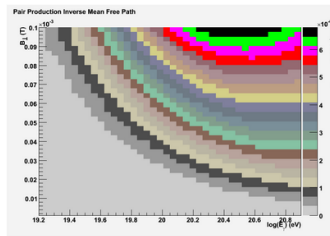
mc.

**mc.Aplanarity**

```
mc.BAbsCosGammaRoeThrust
mc.BAbsCosThetaBStar
mc.BAbsCosThetaCMPV
mc.BAbsCosThetaPrime
mc.BAbsCosThetaTStar
mc.BBU_mb465_mup120_mug27_weight
mc.BCosGammaRoeThrust
mc.BCosThetaBStar
mc.BCosThetaCMPV
```

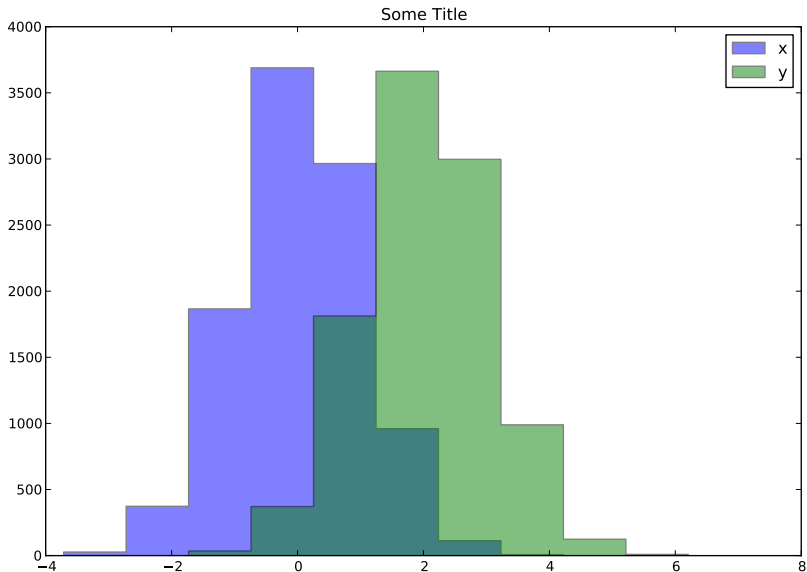
# Plots looks nice by default

- ▶ Needs tons of work to make ROOT plot looks OK. They changed it recently though.
- ▶ Gray background by default. Why? Really?
- ▶ Default color for COLZ.
  - ▶ Legend says they are the 16 color supported by color screen back then.
- ▶ No transparent color!!
- ▶ Matplotlib. Python plotting library.  
<http://matplotlib.org/>
- ▶ Huge Gallery  
<http://matplotlib.org/gallery.html>
- ▶ Extensive documentation.



# Plotting syntax

Let's try to make a simple plot



# Plotting Syntax

## ROOT. Black magic.

```
tree->Draw("x");
TH1F *xhist = (TH1F*)gPad->GetPrimitive("htemp");
htemp->SetLineColor(kRed);
tree->Draw("y>>h2", "same");
TH1F *yhist = (TH1F*)gPad->GetPrimitive("h2");
yhist->SetLineColor(kBlue);
htemp->SetTitle("Magic!!!");
Legend* leg = new TLegend(0.1,0.7,0.48,0.9);
leg->SetHeader("The Legend Title");
leg->AddEntry(xhist, "x");
leg->AddEntry(yhist, "y");
leg->Draw();
```

## Matplotlib. Named argument.

```
hist([x,y], histtype='stepfilled', label=['x','y'],
 color=['blue','green'], alpha=0.5)
title("Some Title")
legend() #yep that simple.
```

## Bonus

```
In [5]: x = randn(10000)
 y = randn(10000)+2
 figure(figsize=(10,7))
 hist(x, histtype='stepfilled', label='x', alpha=0.5);
 hist(y, histtype='stepfilled', label='y', alpha=0.5);
 hist(x, bins=10, range=None, normed=False, weights=None, cumulative=False,
 bottom=None, histtype='bar', align='mid', orientation='vertical', rwidth=None,
 log=False, color=None, label=None, hold=None, **kwargs)
 Call signature::
 (array([18, 128, 526, 1465, 2568, 2688, 1721, 686, 163, 37]), array([-3.63379695,
```



# Multivariate Analysis and Fitting

- ▶ Python has tons of packages to do multivariate analysis.
  - ▶ Most popular one is scikit-learn <http://scikit-learn.org/>
  - ▶ A Bunch of neural network library too.
- ▶ Fitting takes advantage of Python introspection. You can ask a python function: Hey, what are your arguments?
- ▶ This means minimizer can automagically recognizes argument names as parameters. No need to repeat yourself.

---

```
def f(x,y,z):
 return (x-2)**2+(y-3)**2+(z-4)**2
m = Minuit(f)#it knows arguments are x,y,z
m.migrad()
print m.values #{ "x":2., "y":3., "z":4. }
```

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- ▶ Minuit and Likelihood/ $\chi^2$  construction. With introspection and much more.
  - ▶ <https://github.com/iminuit/iminuit>
  - ▶ <https://github.com/iminuit/probfit>

---

```
def pdf(x, mu, sigma, alpha):
 return complicated_function(x,mu,sigma,alpha)
lh = UnbinnedLH(pdf,data) # knows about mu, sigma, alpha
m = Minuit(lh)
m.migrad()
```

---

# Conclusion

## Topics

- ▶ Basic Python
- ▶ Reading ROOT File and Plotting
- ▶ Multivariate Analysis
- ▶ Fitting

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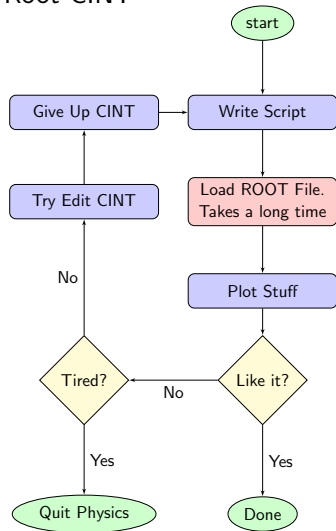
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Backup

# Good Interactive Environment will Change Your Workflow

## Root CINT



## IPython + Matplotlib

