Improving Analysis Workflow with IPython

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January 2, 2013

Advertisement

Time and Location:

- Setup Session. 1 hour.
  Monday Jan 28 2013 12:20pm-13:20pm Redwood C/D.
- Tutorial Session. 4 hour.
  Thursday Jan 31 2013 8:30am-12:30pm Redwood C/D.

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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

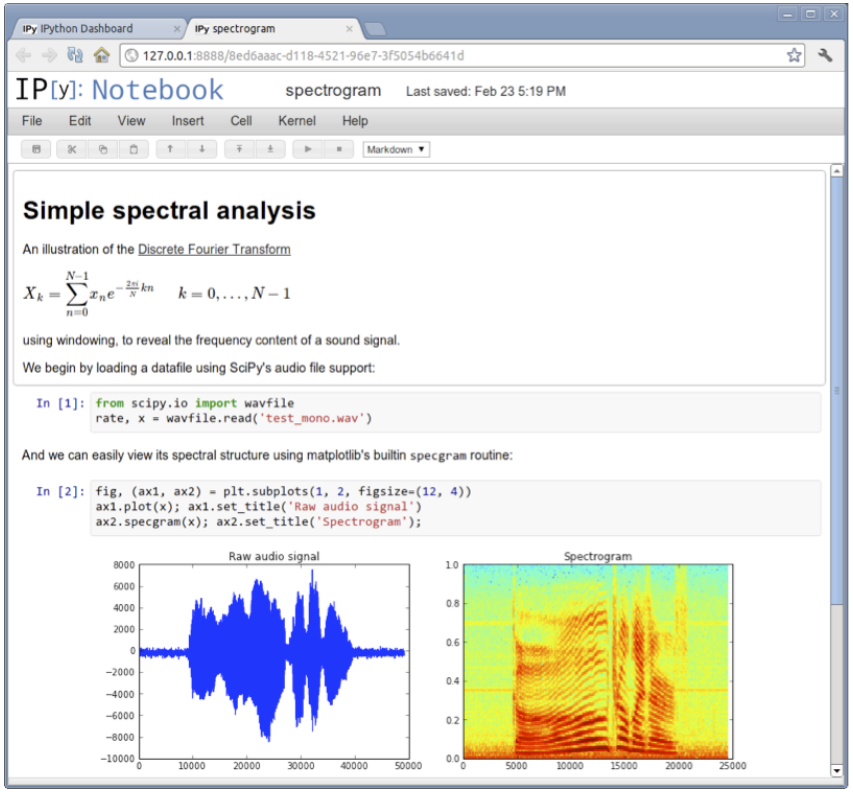
```
data = root2rec("myfile.root")#treename is optional
print data.x[10]
```

  - 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.
- inumpy
  - https://github.com/piti118/inumpy



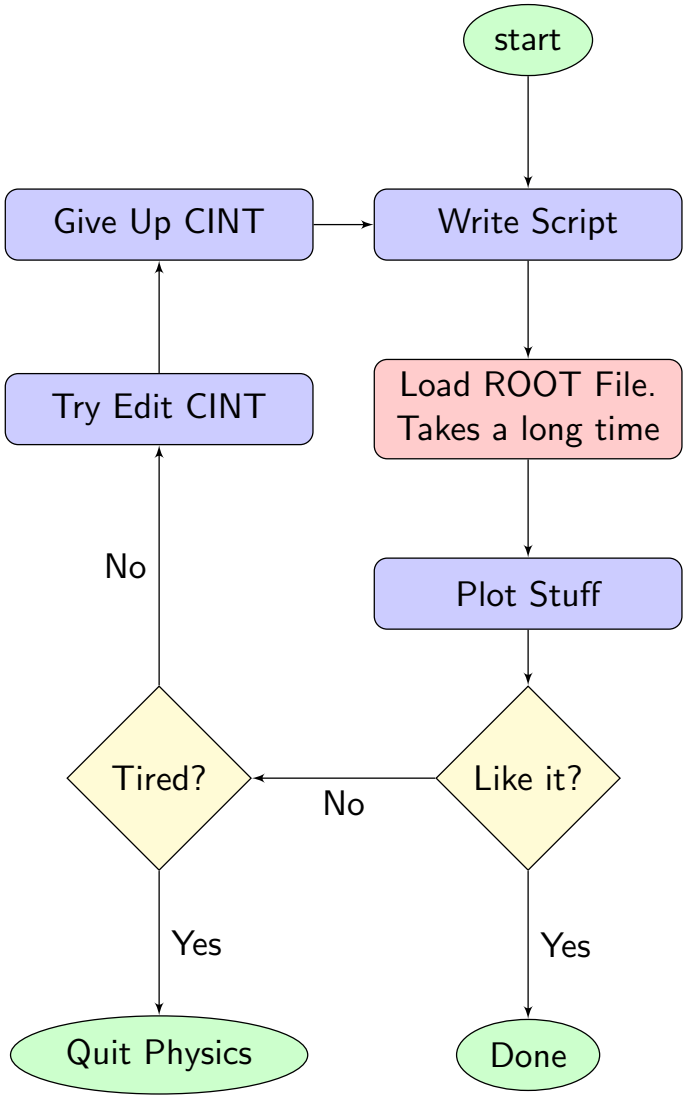

```
mc = root2rec('SP1005_Run1.root','cand')
```

```
mc.
```

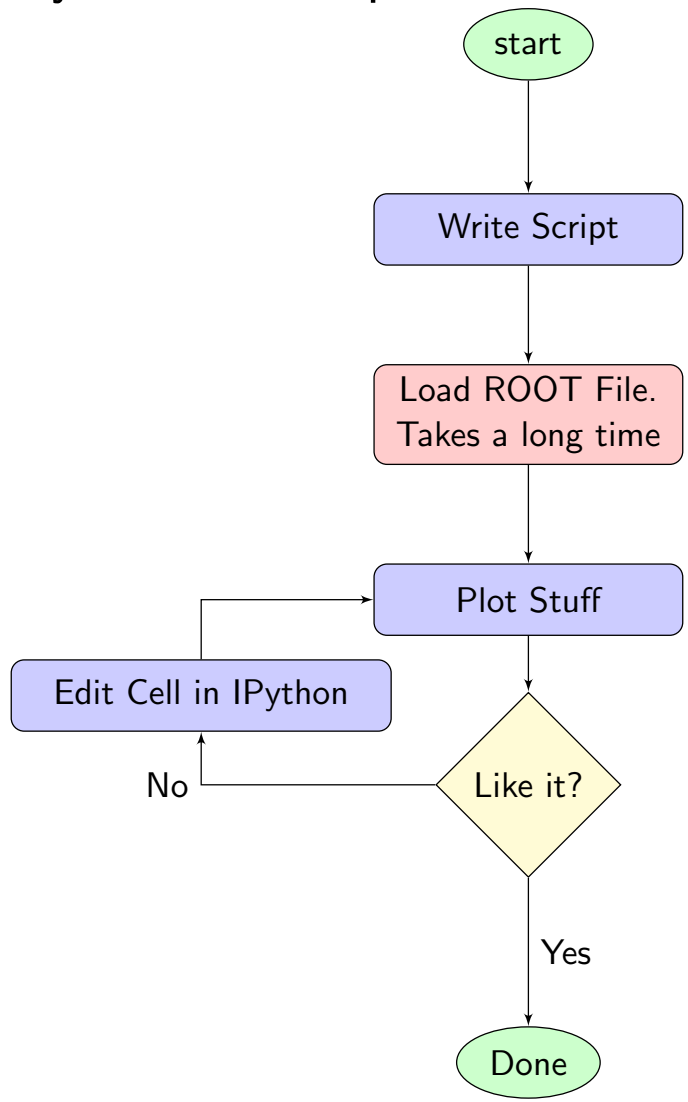
```
mc.Aplanarity
mc.BAbsCosGammaRoeThrust
mc.BAbsCosThetaBStar
mc.BAbsCosThetaCMPV
mc.BAbsCosThetaPrime
mc.BAbsCosThetaTStar
mc.BBU_mb465_mupi20_mug27_weight
mc.BCosGammaRoeThrust
mc.BCosThetaBStar
mc.BCosThetaCMPV
```

Good Interactive Environment will Change Your Workflow

Root CINT

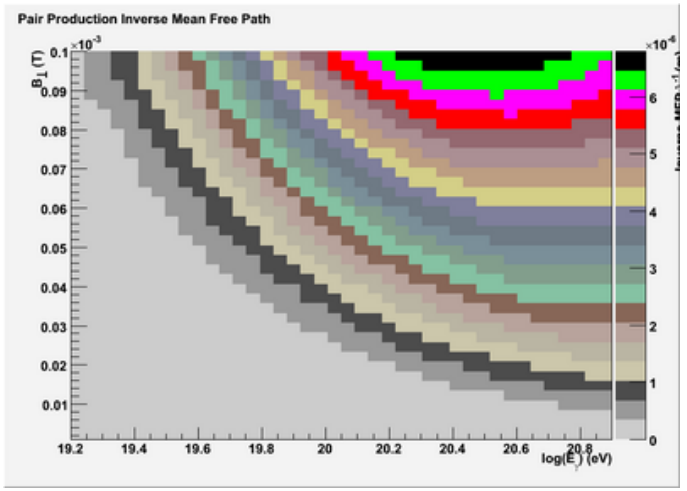


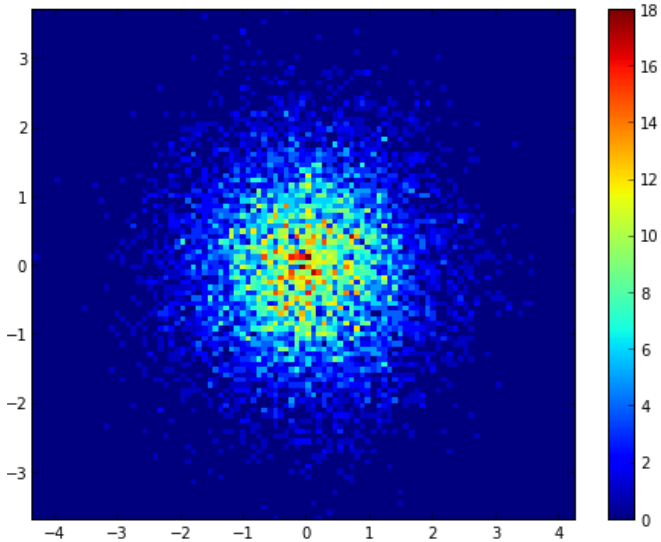
IPython + Matplotlib



Plots looks nice by default

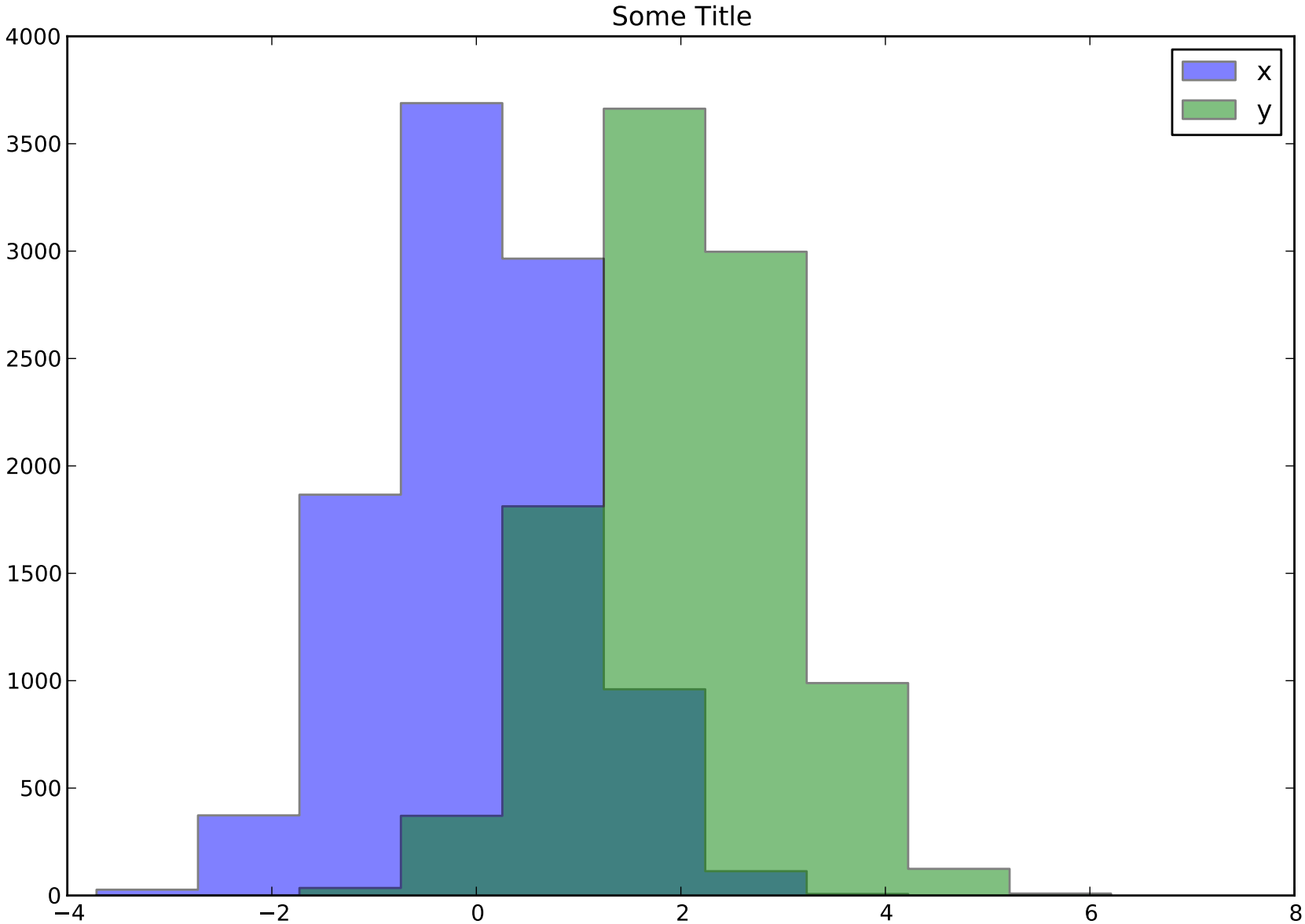
- Needs tons of work to make ROOT plot looks OK. They changed it recently though.
- Gray background by default. Why? Really?
- Default color for COLZ.
  - Legend says they are the 16 color supported by color screen back then.
- No transparent color!!
- Matplotlib. Python plotting library. http://matplotlib.org/
- 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,
        -1.49456578, -0.78148872,
```

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.}
```

- Minuit and Likelihood/χ^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 = BinLH(pdf,data)#knows about mu, sigma, alpha
m = Minuit(lh)
m.migrad()
```

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