Improving Analysis Workflow with IPython

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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.

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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

- ▶ 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.
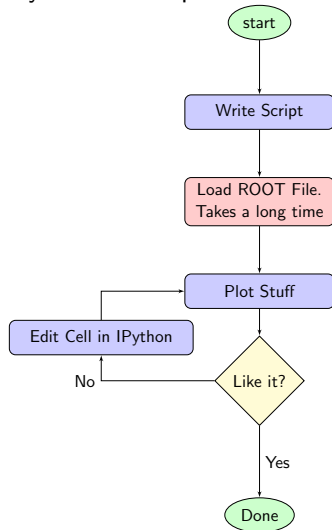- ▶ Autocomplete. Docstring. IPython magic.
- ▶ inumpy
  - ▶ https://github.com/piti118/inumpy
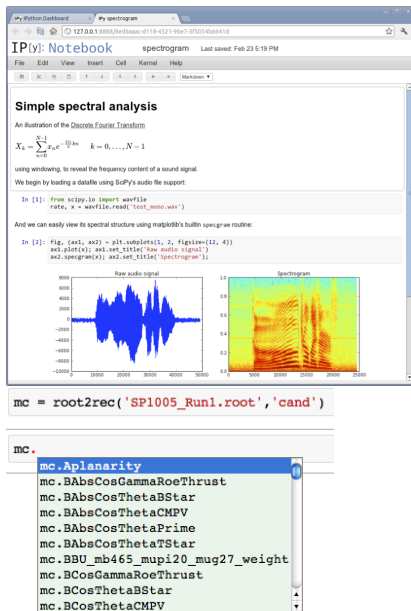
# Good Interactive Environment will Change Your Workflow

Root CINT
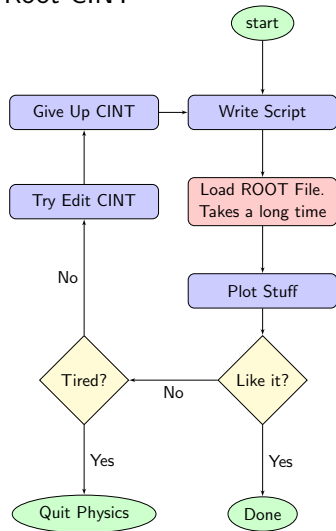
IPython + Matplotlib

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.
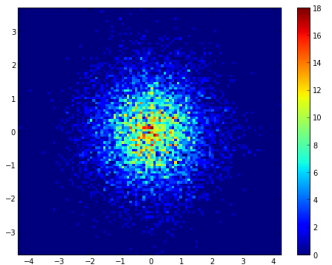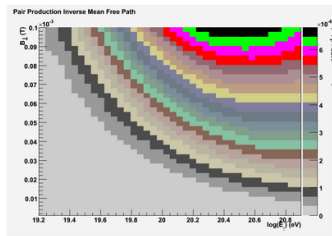
Plotting syntax

Let's try to make a simple plot
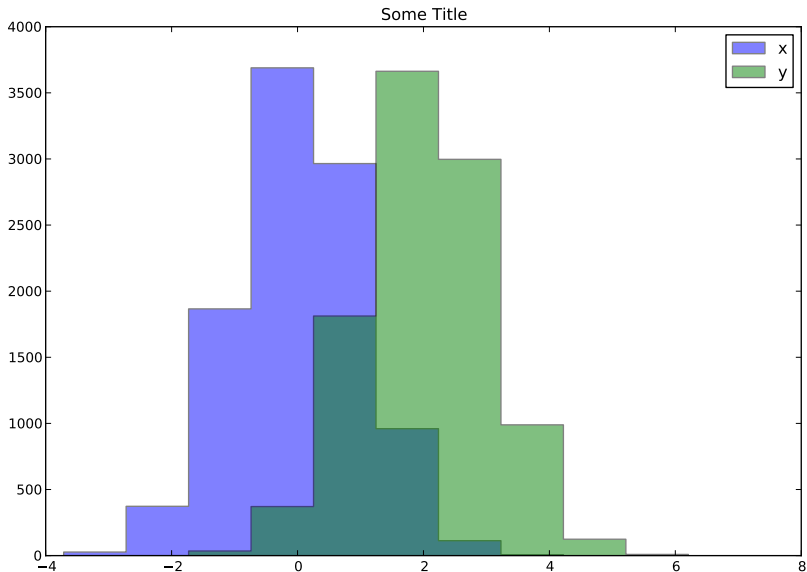
Plotting Syntax

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([-3.63379696,
    -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.

```python
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

```python
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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