ROOT5

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Philosophy

ROOT was written by people who haven't done physics for 20 years for people who won't do physics for 20 years.

Back in the day it was Fortran and Geant3 and Paw. Now it's C++ and Geant4 and ROOT, oh my!

Segfaults are the norm when working with ROOT.

ROOT is object oriented. If you want to use a histogram you better know the name of the class (TH1) and if you want to make a histogram you better know what the member fucnctions of the class are. Replace histogram with anything you will ever do. If you know the name of the class you can google it (eg **follow me***), if you don't know the name of the class you're screwed!*

Outline

Let's Get Acquainted

Where Am I

- shell prompt: [user@pc ∼]$
- ROOT prompt: root [0]

Starting ROOT

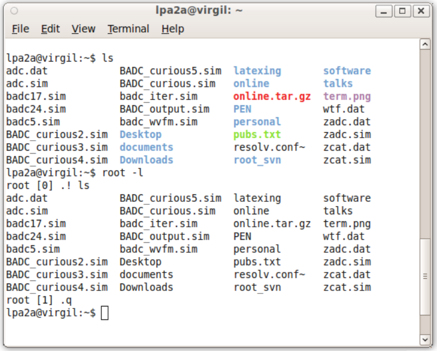
- [user@pc ∼]$ root -l

Quitting ROOT

- root [0] .q

Shell Commands in root start with ".!"

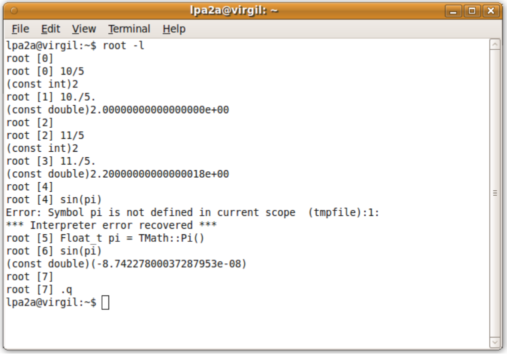
- root [0] .! ls . | grep pdf



```
lpa2a@virgil:~$ ls
adc.dat             BADC_curious5.sim  latexing       software
adc.sim             BADC_curious.sim   online         talks
badc17.sim          badc_iter.sim      online.tar.gz  term.png
badc24.sim          BADC_output.sim    PEN            wtf.dat
badc5.sim           badc_wvfm.sim      personal       zadc.dat
BADC_curious2.sim   Desktop            pubs.txt       zadc.sim
BADC_curious3.sim   documents          resolv.conf~   zcat.dat
BADC_curious4.sim   Downloads          root_svn       zcat.sim
lpa2a@virgil:~$ root -l
root [0] .! ls
adc.dat             BADC_curious5.sim  latexing       software
adc.sim             BADC_curious.sim   online         talks
badc17.sim          badc_iter.sim      online.tar.gz  term.png
badc24.sim          BADC_output.sim    PEN            wtf.dat
badc5.sim           badc_wvfm.sim      personal       zadc.dat
BADC_curious2.sim   Desktop            pubs.txt       zadc.sim
BADC_curious3.sim   documents          resolv.conf~   zcat.dat
BADC_curious4.sim   Downloads          root_svn       zcat.sim
root [1] .q
lpa2a@virgil:~$ 
```

http://root.cern.ch/root/doc/RootDoc.html

Simple Operations

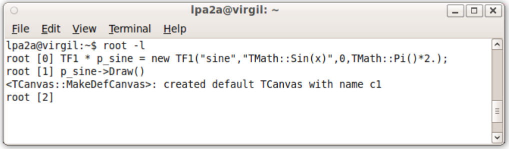


```
lpa2a@virgil:~$ root -l
root [0]
root [0] 10/5
(const int)2
root [1] 10./5.
(const double)2.00000000000000000e+00
root [2]
root [2] 11/5
(const int)2
root [3] 11./5.
(const double)2.20000000000000018e+00
root [4]
root [4] sin(pi)
Error: Symbol pi is not defined in current scope  (tmpfile):1:
*** Interpreter error recovered ***
root [5] Float_t pi = TMath::Pi()
root [6] sin(pi)
(const double)(-8.74227800037287953e-08)
root [7]
root [7] .q
lpa2a@virgil:~$
```

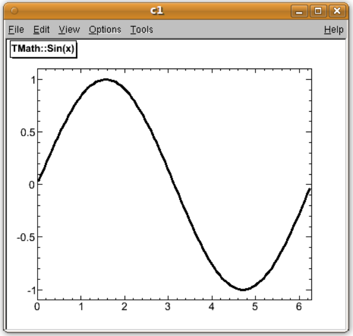
ROOT can do simple calculations. But be careful, ROOT is using a C++ interpreter. It knows some things but not everything. Do not forget decimal points when using floating numbers!

Make a Plot, Save a Plot

Let's draw a sine function. ROOT will automaticall take care of most things for us. All we need to do it tell root what our function is (and then of course tell ROOT to draw the function).



```
lpa2a@virgil:~$ root -l
root [0] TF1 * p_sine = new TF1("sine","TMath::Sin(x)",0,TMath::Pi()*2.);
root [1] p_sine->Draw()
<TCanvas::MakeDefCanvas>: created default TCanvas with name c1
root [2]
```



To save the plot type Alt+F then s then d to save as a pdf file. When you save the plot with an extension it will write the data to file in the appropriate format such as pdf or eps, take note of all the saving options (ps,eps,pdf,gif,jpg,png,C,root).

Some Object Oriented Fun

Now let's make the sine function a little more robust. Try creating the sine function the following way:

```
TF1 *pf = new TF1("f","[0]+[1]*TMath::Sin([2]*x+[3])",-10,10);
pf->SetParName(0,"offset");
pf->SetParName(1,"amplitude");
pf->SetParName(2,"freqency");
pf->SetParName(3,"phase");
pf->SetParameter(0,6);
pf->SetParameter(1,3);
pf->SetParameter(2,5);
pf->SetParameter(3,1);
pf->Draw();
```

1D Histograms TH1

To Draw a histogram you must do the following steps. Feel free to follow along.

- Construct: TH1F * p_histogram = new TH1F("histogram","Title:Horizontal Axis Label",100,0,10)
- Fill: p_histogram->Fill(3.)
- Draw: p_histogram->'Draw()

Did you notice that the title for this slide is a hyperlink to the online documentation of TH1F?

Functions TF1

TMath::Pi()

ROOT files

.C files

Fitting Functions Theory

Presumably one would like to describe their results qantitatively with a theory. Often this theory will take the form of a function. ROOT offers the user two ways to fit data to functions: **Standard Packages** and **RooFit** (see `http://roofit.sourceforge.net/`). For simple tasks the standard packages are sufficient. More complex taks such as maximum likelyhood anlysis should be tackled with roofit. Roofit is beyond the scope of this work and will not be mentioned again (maybe).

Using the Standard ROOT packages to execute a fit the user must:

- Create a function
- Create the object to fit
- Initialize the parameters of the function **(good guesses are critical)**
- Execute a fit command

Fitting Functions Example

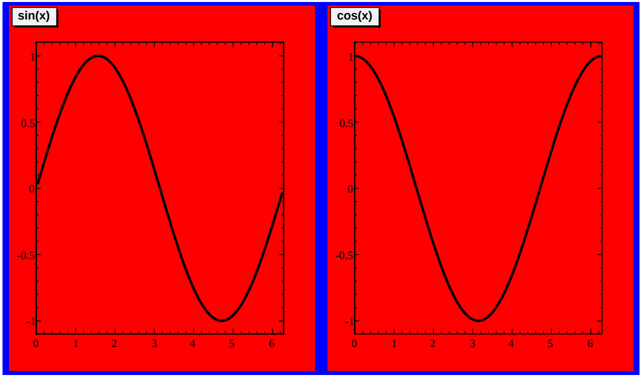
- Assume pHist is a pointer to a histogram you want to fit

```
TF1 *pf2 = new TF1("f2","[0]+[1]*TMath::Sin([2]*x+[3])",-10,10);
pf2->SetParName(0,"offs");
pf2->SetParName(1,"ampl");
pf2->SetParName(2,"freq");
pf2->SetParName(3,"phas");
pf2->SetParameter(0,6);
pf2->SetParameter(1,3);
pf2->SetParameter(2,5);
pf2->SetParameter(3,1);
pf2->Draw();
pHist->Fit("f2","R+");
pHist->Draw();
```

ROOT Display

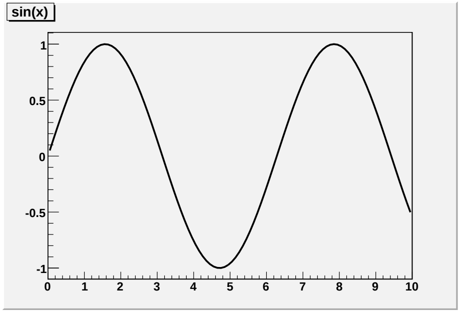
Again C++ objects

- TCanvas
- TPad
- TF1

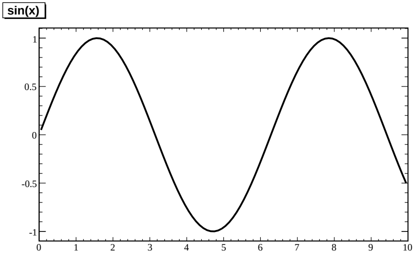


∼/.rootlogon.C

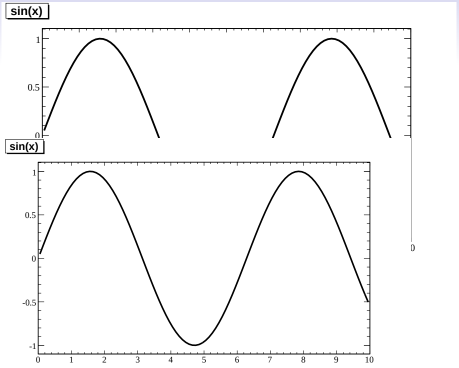
Default ROOT Appearence

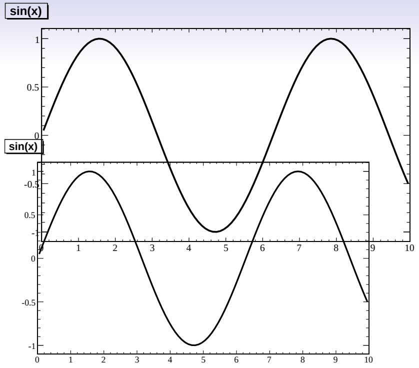


Modified ROOT Appearence



- The default root appearance is atrocious
- Edit ∼/.rootlogon.C to fix
- Use TStyle::Set methods to choose defaults (sample on next line)
    - pTStyle->SetCanvasColor(0); // Sets Canvas color to white

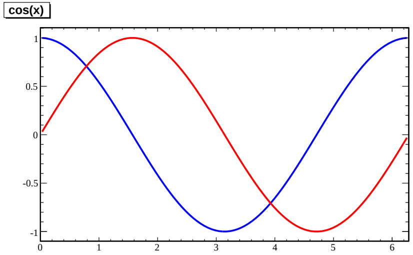


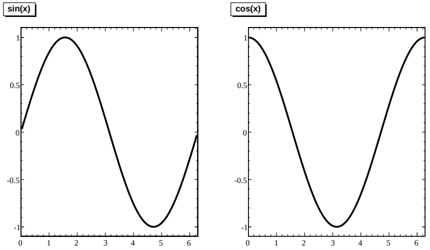


- ∼/.rootlogon.C cannot fix everything
- The canvas should be transparent
- call canvas->SetFillStyle() to change transparency of canvas
- But style->SetCanvasFillStyle() does not exist
- You must set the transparency by hand after the canvas is constructed

Double Down or Split

```
double pi=3.14159;
TF1 * psin = new TF1("sin","sin(x)",0.,2.*pi);
TF1 * pcos = new TF1("cos","cos(x)",0.,2.*pi);
```





```
pcos->SetLineColor(4);
psin->SetLineColor(2);
pcos->Draw();
psin->Draw("same");
```

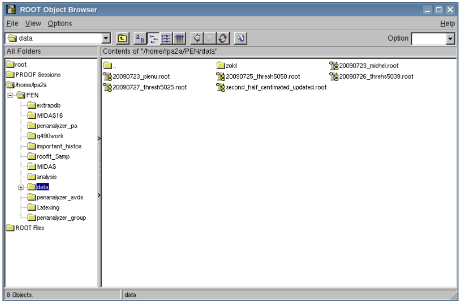
```
pTCanvas->Divide(2,1);// r,c
pTCanvas->cd(1);
psin->Draw();
pTCanvas->cd(2);
pcos->Draw();
```

selector

TBrowser

So now you've got this root file and you want to look at it.

- root [0] new TBrowser
- Navigate around
- Dopple Click on a root file
- Find a folder with a tree on it
- Right Click it and select "StartViewer"



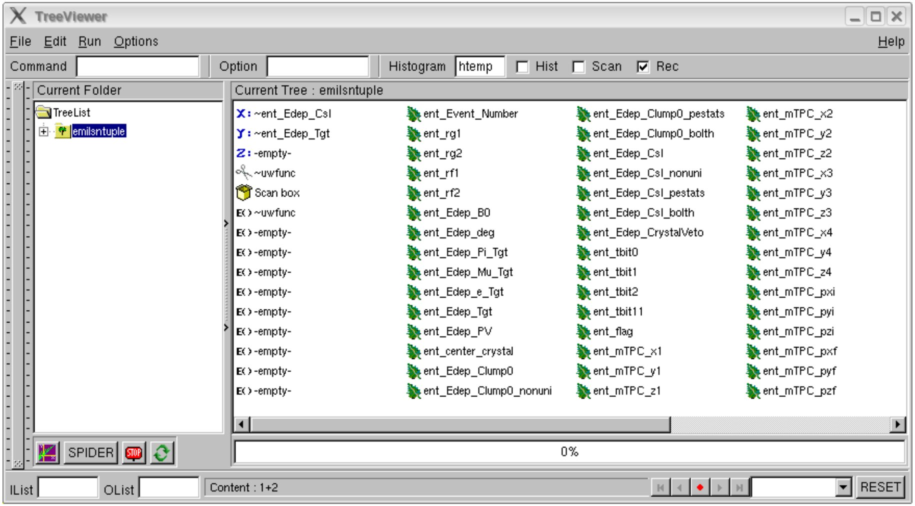
root
PROOF Sessions
/home/lpa2a
PEN
extraodb
MIDAS16
penanalyzer_pa
g490work
important_histos
roofit_Samp
MIDAS
analysis
data
penanalyzer_avds
Latexing
penanalyzer_group
ROOT Files

Contents of "/home/lpa2a/PEN/data"

```
..                        zold                                 20090723_michel.root
20090723_pienu.root       20090725_thresh5050.root             20090726_threhs5039.root
20090727_thresh5025.root  second_half_centimated_updated.root
```

8 Objects. data

TreeViewer



Command [ ] Option [ ] Histogram htemp [ ] Hist [ ] Scan [✓ Rec]

Current Tree : emilsntuple

```
X: ~ent_Edep_CsI   ent_Event_Number       ent_Edep_Clump0_pestats  ent_mTPC_x2
Y: ~ent_Edep_Tgt   ent_rg1                ent_Edep_Clump0_bolth    ent_mTPC_y2
Z: -empty-         ent_rg2                ent_Edep_CsI             ent_mTPC_z2
~uwfunc            ent_rf1                ent_Edep_CsI_nonuni      ent_mTPC_x3
Scan box           ent_rf2                ent_Edep_CsI_pestats     ent_mTPC_y3
E() ~uwfunc        ent_Edep_B0            ent_Edep_CsI_bolth       ent_mTPC_z3
E() -empty-        ent_Edep_deg           ent_Edep_CrystalVeto     ent_mTPC_x4
E() -empty-        ent_Edep_Pi_Tgt        ent_tbit0                ent_mTPC_y4
E() -empty-        ent_Edep_Mu_Tgt        ent_tbit1                ent_mTPC_z4
E() -empty-        ent_Edep_e_Tgt         ent_tbit2                ent_mTPC_pxi
E() -empty-        ent_Edep_Tgt           ent_tbit11               ent_mTPC_pyi
E() -empty-        ent_Edep_PV            ent_flag                 ent_mTPC_pzi
E() -empty-        ent_center_crystal     ent_mTPC_x1              ent_mTPC_pxf
E() -empty-        ent_Edep_Clump0        ent_mTPC_y1              ent_mTPC_pyf
E() -empty-        ent_Edep_Clump0_nonuni ent_mTPC_z1              ent_mTPC_pzf
```

Content : 1+2

Sometimes you know you want to analyze your root files in the same way every time. There is no need to use the TBrowser/TreeViewer, just make some macaroni and cheese.

Macaroni and Cheese

(Macros and Chains)

- Create a file called blerg.C:
- void blerg() { TChain * pchain = new TChain("ntuple");
  TH1F * phist1 = new TH1F("hist1","",160,0.,80.);
  TH1F * phist2 = new TH1F("hist2","",160,0.,80.);
  pchain->Add("file_1.root"); // **nb: ntuple must be in file_1.root**
  pchain->Add("file_2.root"); // and so on
  Float_t g = 68./68.4;
  pchain->Draw("tree_leaf>>phist1","cuts");
  // the >> fills phist1 with the variable tree_leaf
  pchain->Draw(Form("tree_leaf*%f>>phist2",g),"cuts");
  // Form replaces %f in the string with g
  phist1->Draw();
  phist2->Draw("same");}
- root [0] .x blerg.C

Compiled Root Code

You can't just use g++ to compile C++ code with root classes. You should use a makefile. E.G. where *foo* is the name of the file (foo.c) that contains the main function.

```
ROOTCFLAGS = $(shell $(ROOTSYS)/bin/root-config –cflags)
ROOTLIBS = $(shell $(ROOTSYS)/bin/root-config –libs)
ROOTGLIBS = $(shell $(ROOTSYS)/bin/root-config –glibs)
CXX = g++
CXXFLAGS = -g -Wall -O2 -fPIC
LD = g++
LDFLAGS = -g
SOFLAGS = -shared
CXXFLAGS += $(ROOTCFLAGS)
LIBS = $(ROOTLIBS)
NGLIBS = $(ROOTGLIBS)
NGLIBS += -lMinuit
GLIBS = $(filter-out -lNew, $(NGLIBS))
.SUFFIXES: .cc,.C
all: foo
foo: foo.o
$(CXX) $(CXXFLAGS) -o $@ foo.o $(GLIBS)
clean::
rm -f *.o *  #*
```

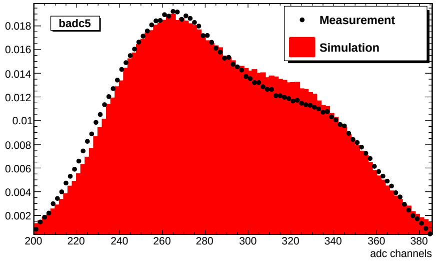
but windows don't open

If you want to open a canvas when running compiled code you must jump through an extra hoop. The TApplication class must be invoked. Simply create an application at the begining of your code then after your work issue the Run() subroutine. E.G.

```
TApplication myapp(”App”,0,0);
TFile * alpha = TFile::Open(”filename.root”,”READ”);
TFolder * pf = (TFolder*) alpha− >Get(”histos”);
TH2F* ph = (TH2F*) pf− >FindObject(”Check/h2TIMING”);
ph− >Draw();
myapp.Run();
```

TLegend

Assume psim4 and pmeas are pointers to histograms



- psim4→ Draw();
- pmeas→ Draw("p,same");
- TLegend * pleg = new TLegend(0.6,0.7,0.89,0.89);
- pleg→ AddEntry(pmeas,"Measurement","P");
- pleg→ AddEntry(psim4,"Simulation","F");
- pleg→ Draw();

Loose Strings

Form("st%fring",float)

fin