Computing and Statistical Data Analysis
Some slides about ROOT

Interactive data analysis program and class library.

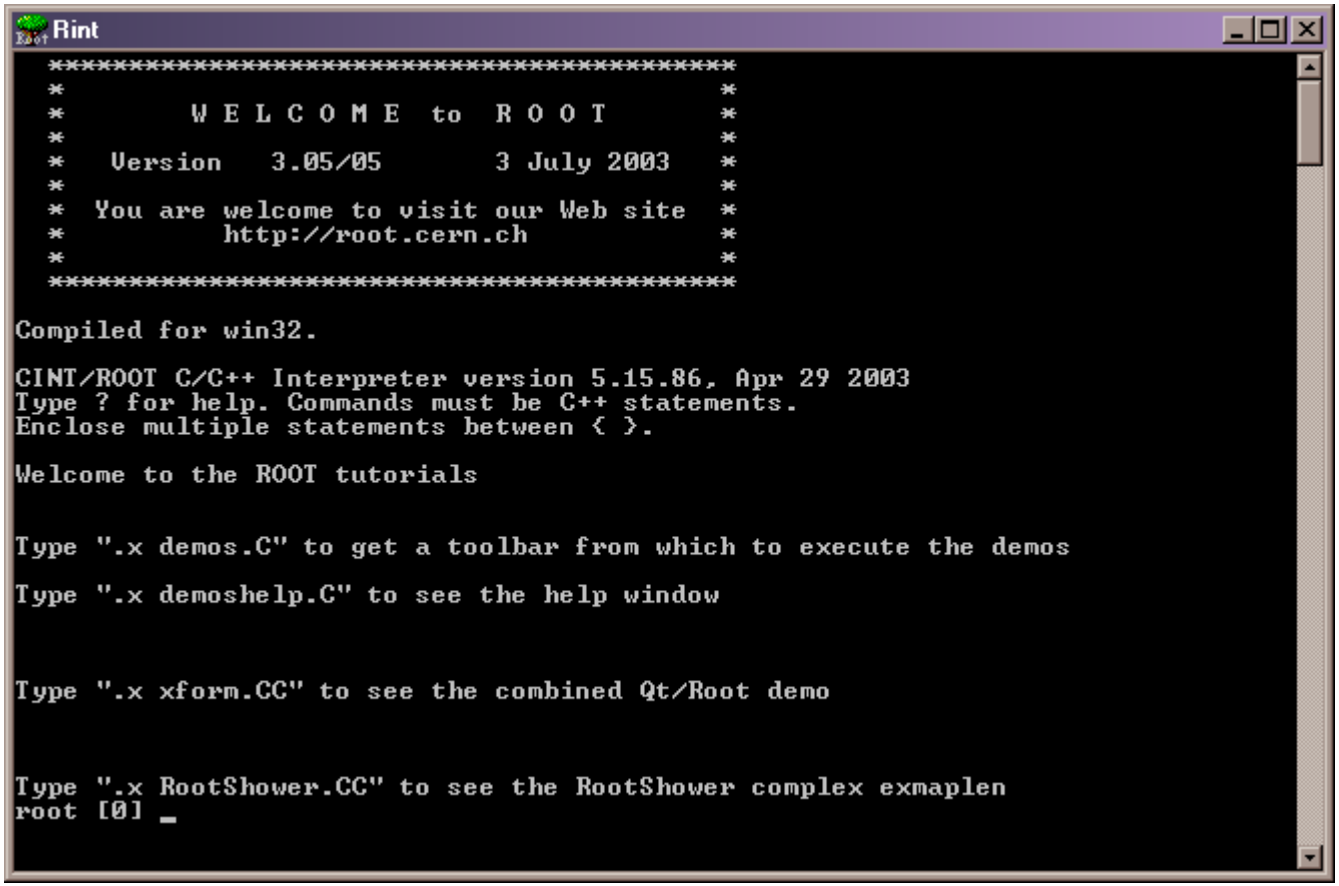
Commands based on C++ (CINT interpreter).

Home page: `root.cern.ch`

Many tutorials, e.g. google for ROOT tutorial

See course web page for stand-alone C++ programs that use ROOT classes, e.g., for histograms.

Run the program

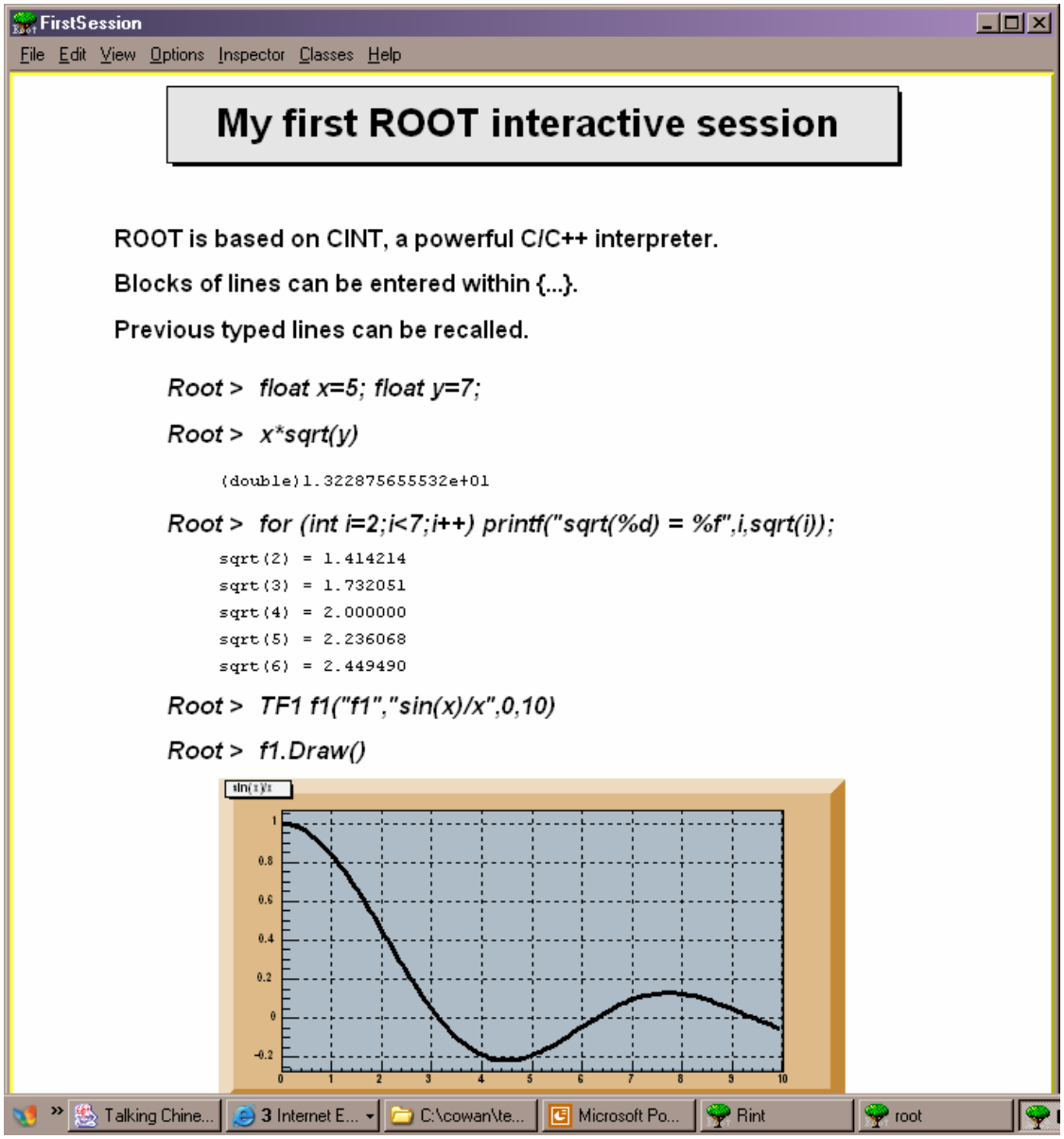


Installation and set up non-trivial. See your local expert.

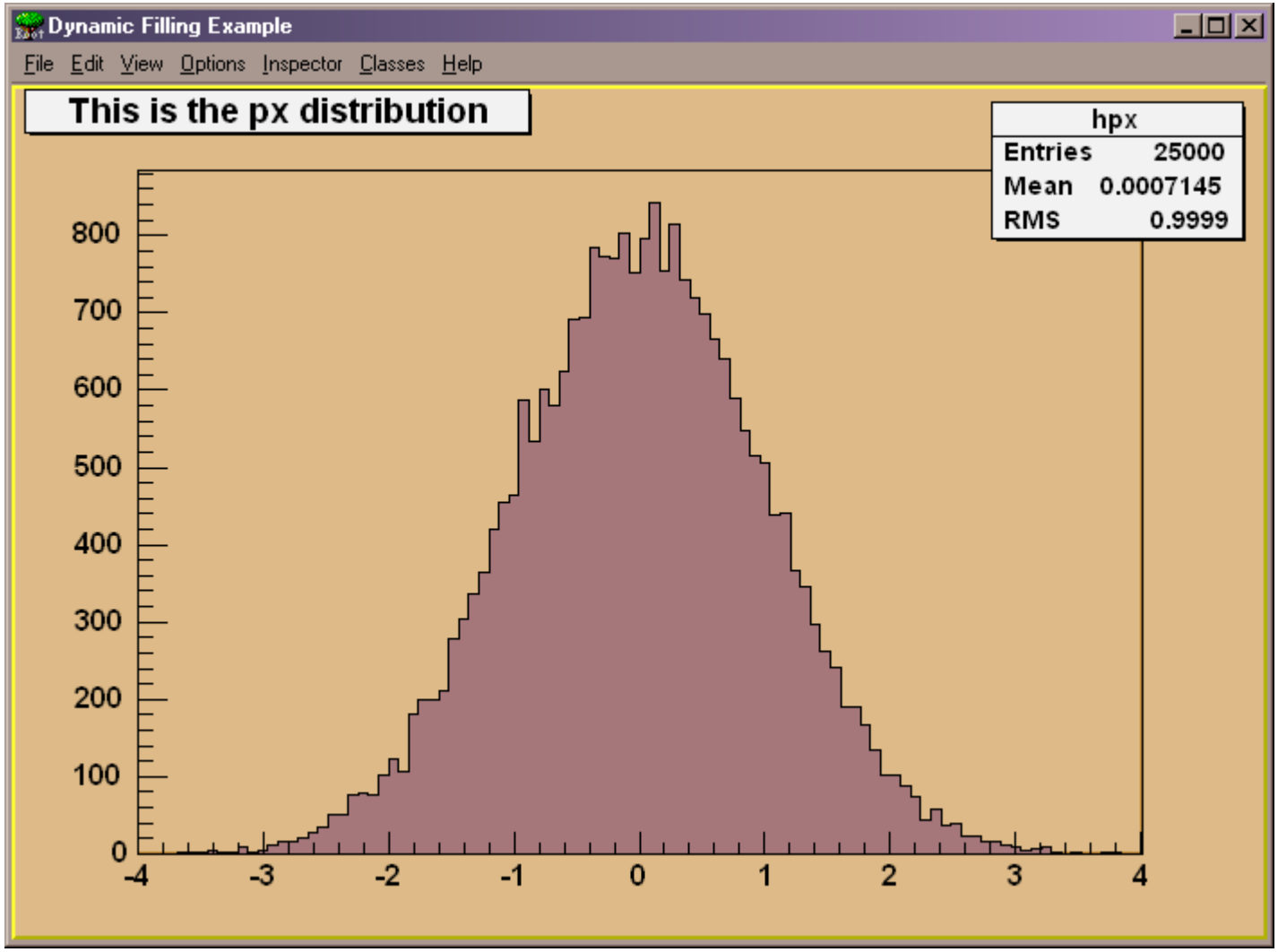
To run, type **`root`**

Run the demo program

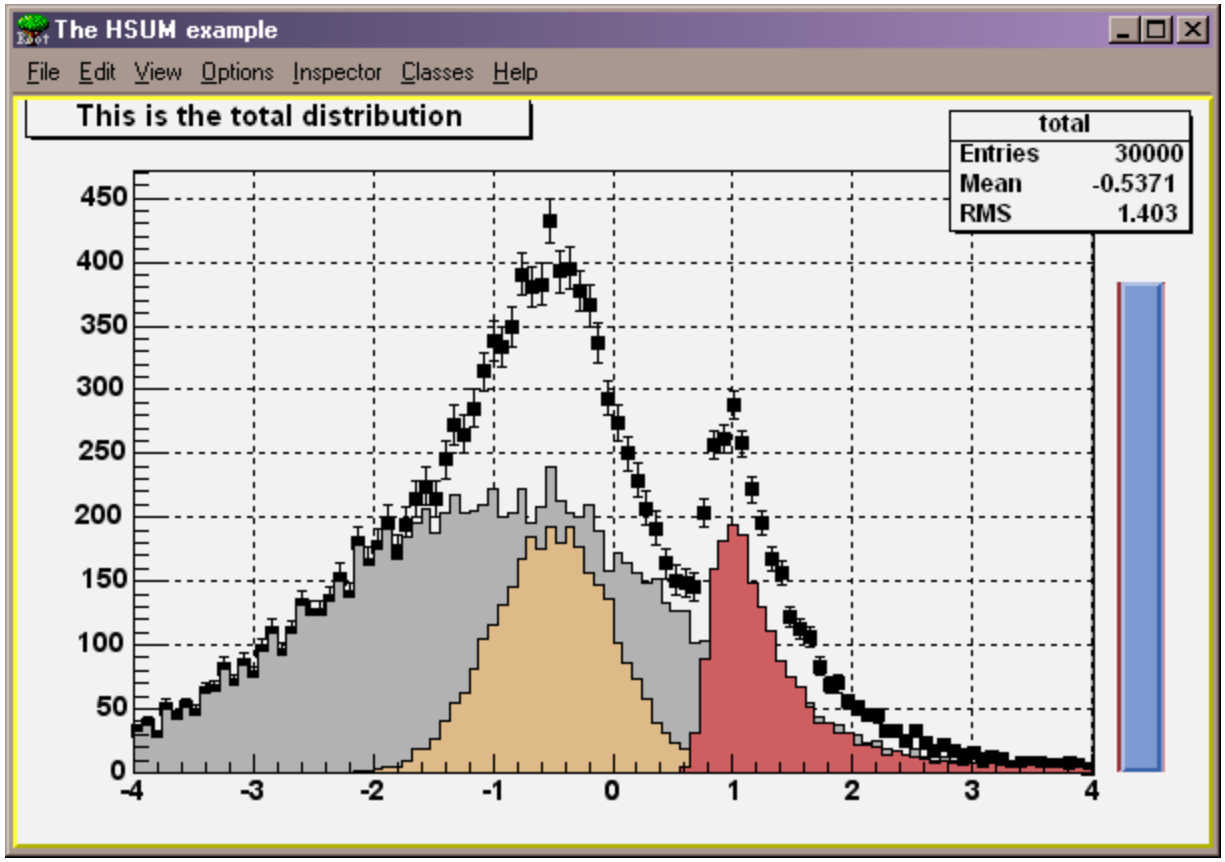
Try typing this stuff in yourself.



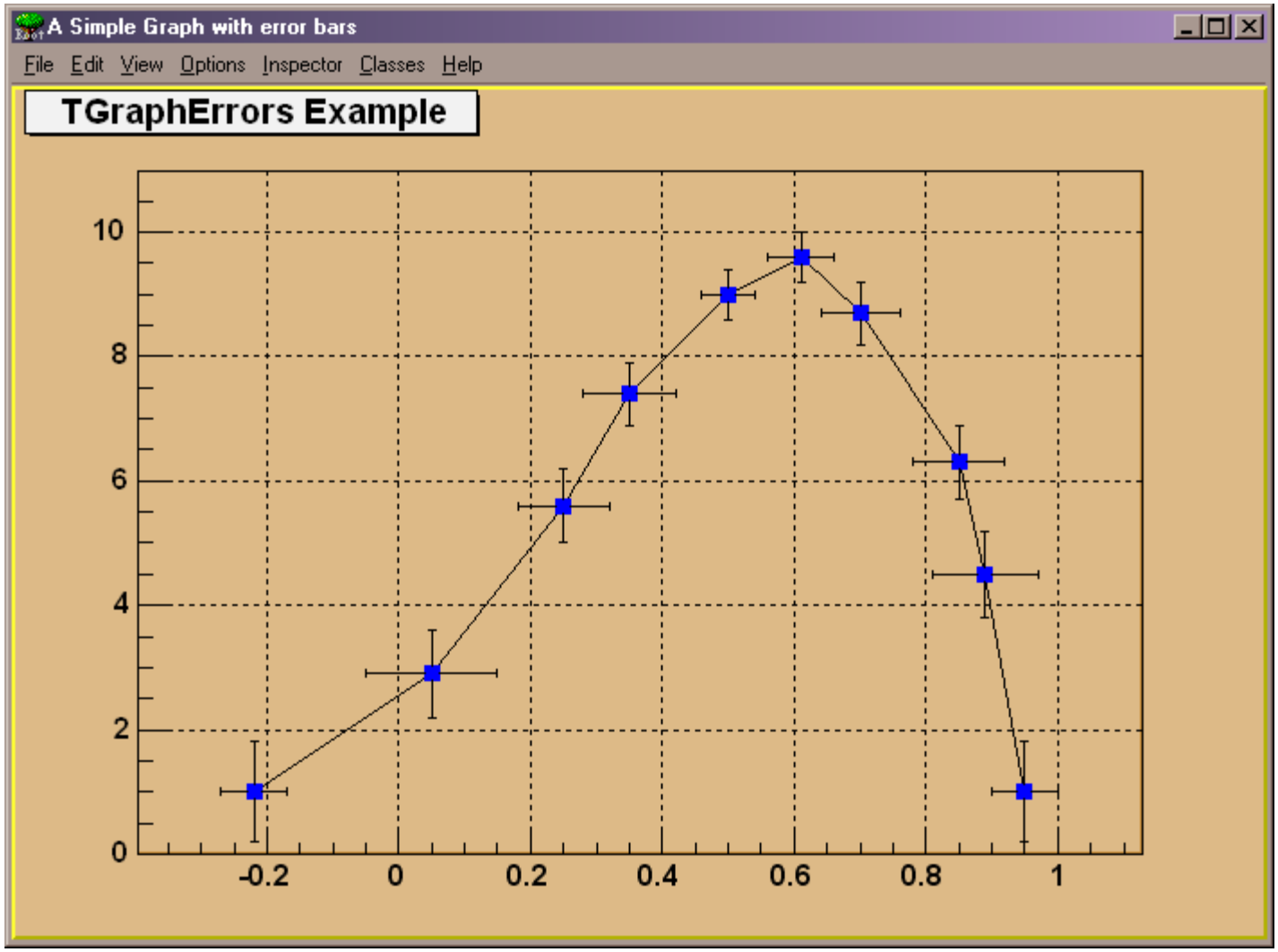
Book, fill, display a histogram



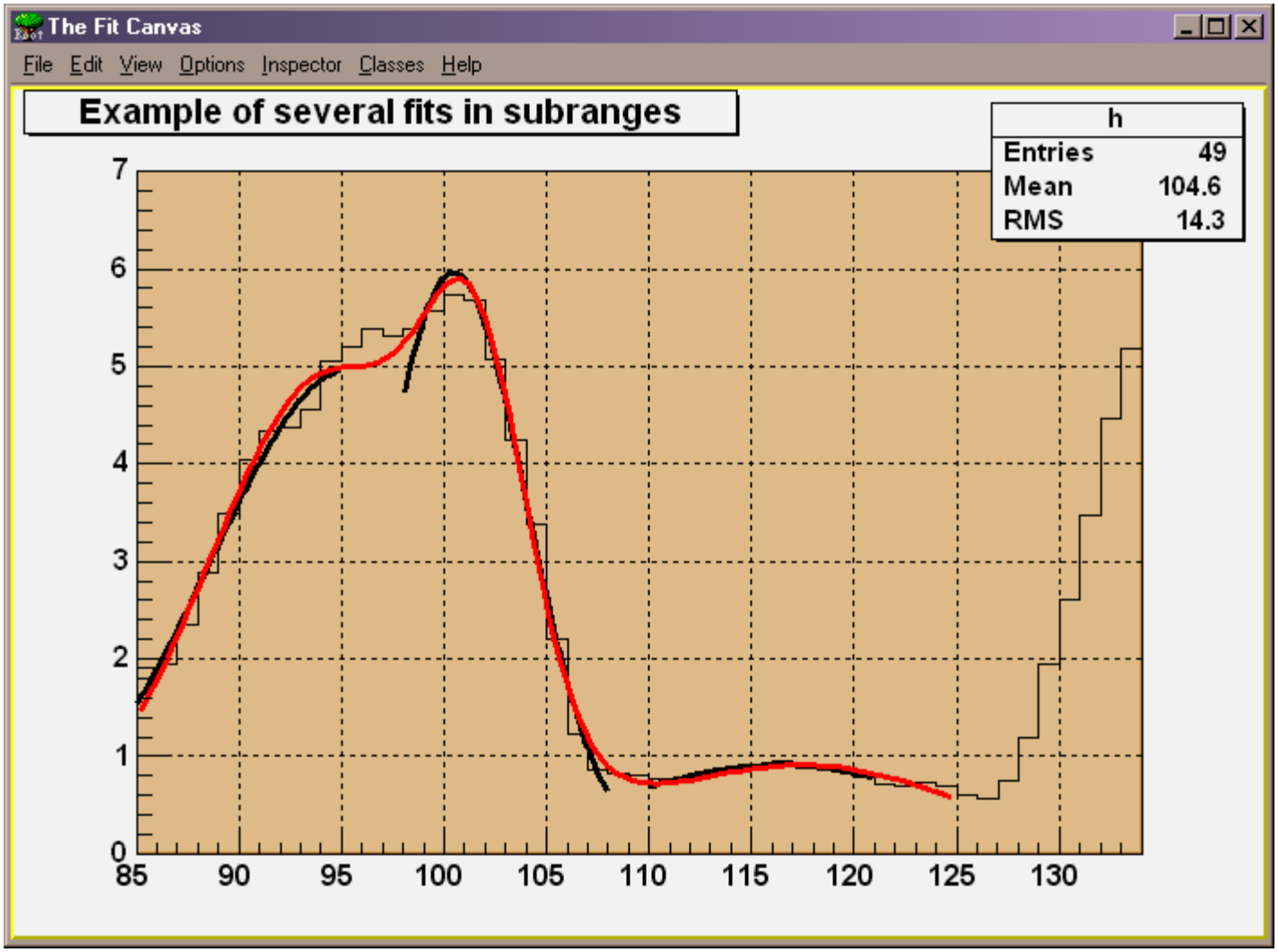
Fancy stuff with histograms



Plot a graph with error bars



Function minimization for fitting



Working with ROOT

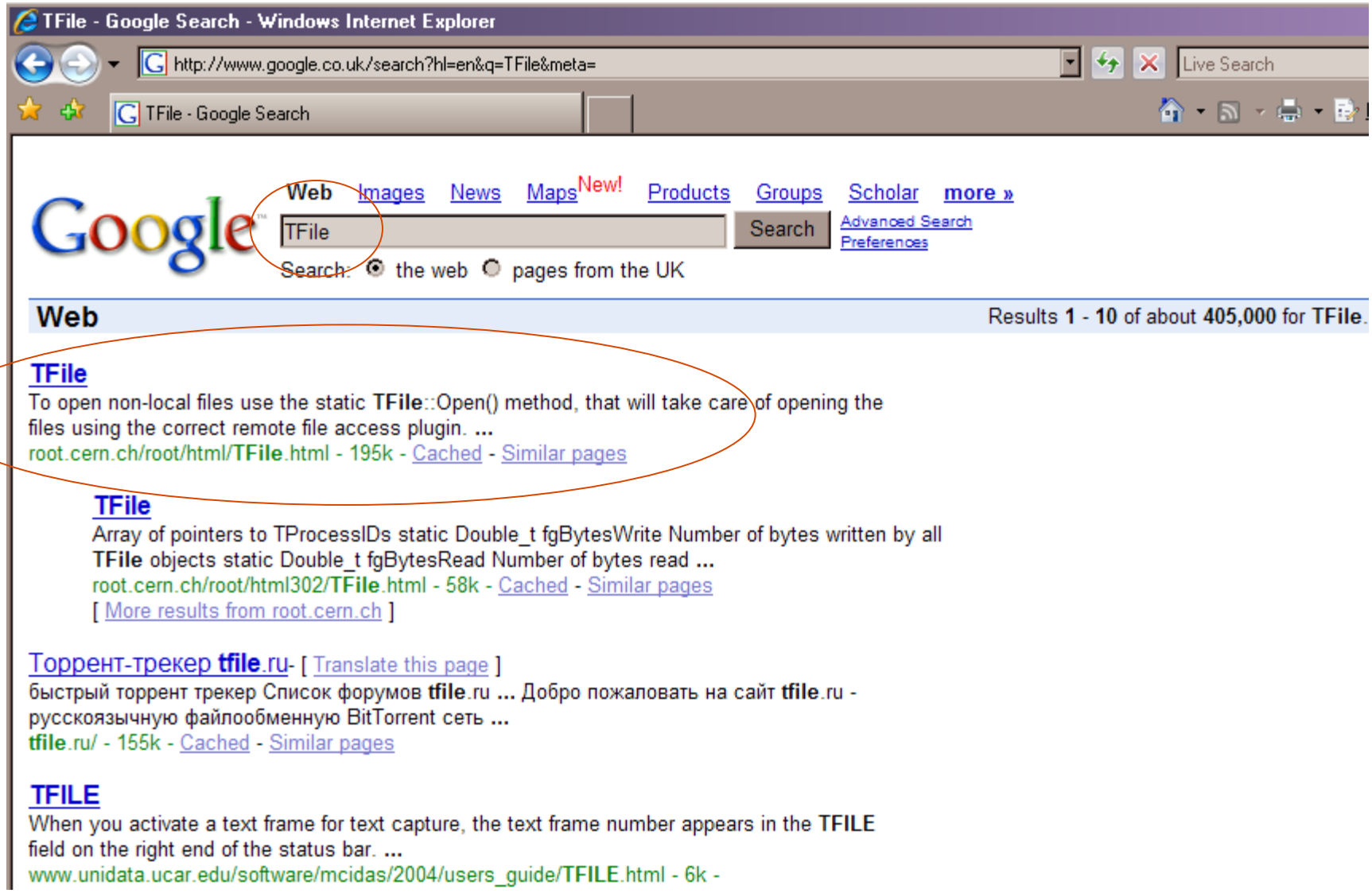
In this course we will write stand-alone C++ programs that use classes from the ROOT library.

Often the program will create histograms (or n-tuples), that we store in a root file (e.g. **`myHistogramFile.root`**) and we can use the ROOT executable program to analyze these.

To work with ROOT classes, e.g., to know what member functions are available, check the class definition on the web.

You can either find the documentation on **`root.cern.ch`** or google for the class name (ROOT classes always start with **`T`**, e.g., **`TFile`**, **`TRandom`**,...)

Googling for ROOT class name usually quickest



Sample program `simpleMC.cc`

Below is a stand alone C++ program that uses ROOT classes for random numbers and histograms:

```
#include <TH1D.h>
#include <TFile.h>
#include <TRandom3.h>

using namespace std;

int main(){

// Open output file

  TFile* file = new TFile("simpleMC.root", "recreate");

// Book histograms

  TH1D* h_Uni = new TH1D("h_Uni", "uniform random numbers",  100,  0, 1.0);
  TH1D* h_Exp = new TH1D("h_Exp", "exponential random numbers",  100,  0, 5.0);
```

simpleMC.cc (2)

```
// Create a TRandom3 object to generate random numbers

  int seed = 12345;
  TRandom3* ran = new TRandom3(seed);

// Generate some random numbers and fill histograms

  const int numValues = 10000;
  const double xi = 1.0;                  // mean of exponential pdf

  for (int i=0; i<numValues; ++i){
    double r = ran->Rndm();               // uniform in ]0,1]
    double x = - xi * log(r);
    h_Uni->Fill(r);
    h_Exp->Fill(x);
  }

// Store all histograms in the output file and close up

  file->Write();
  file->Close();

  return 0;
}
```

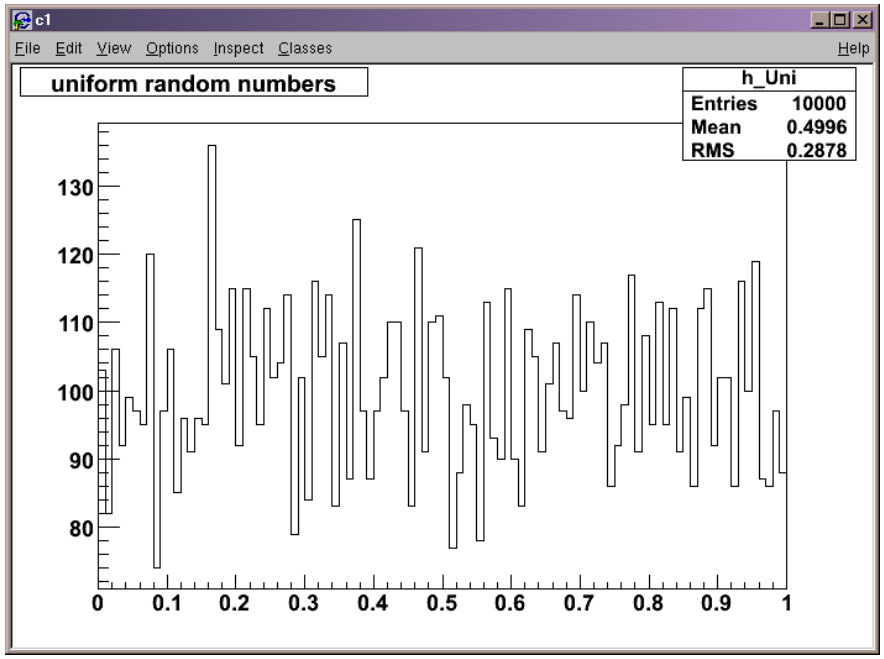
GNUmakefile to build simpleMC

```
PROGNAME       = simpleMC
SOURCES        = simpleMC.cc
INCLUDES       =
OBJECTS        = $(patsubst %.cc, %.o, $(SOURCES))
ROOTCFLAGS    := $(shell root-config --cflags)
ROOTLIBS      := $(shell root-config --libs)
ROOTGLIBS     := $(shell root-config --glibs)
ROOTLIBS      := $(shell root-config --nonew --libs)
CFLAGS        += $(ROOTCFLAGS)
LIBS          += $(ROOTLIBS)
#  Not sure why Minuit isn't being included -- put in by hand
#
LIBS          += -lMinuit
LDFLAGS        = -O

$(PROGNAME):    $(OBJECTS)
                g++ -o $@ $(OBJECTS) $(LDFLAGS) $(LIBS)

%.o : %.cc $(INCLUDES)
        g++ ${CFLAGS} -c  -g -o $@ $<
```

Looking at output `simpleMC.root`

You type at root prompt
(lines numbered [0], [1], etc.)

```
[linappserv2]~/WWW/stat/root/mc> root
********************************
* Welcome to ROOT v5.14/00e *
********************************

root [0] TFile* f = new TFile("simpleMC.root");
root [1] f->ls();
TFile**         simpleMC.root
 TFile*         simpleMC.root
  KEY: TH1D     h_Uni;1 uniform random numbers
  KEY: TH1D     h_Exp;1 exponential random numbers
root [2] h_Uni->Draw();
<TCanvas::MakeDefCanvas>: created default TCanvas with name c1
root [3]
```

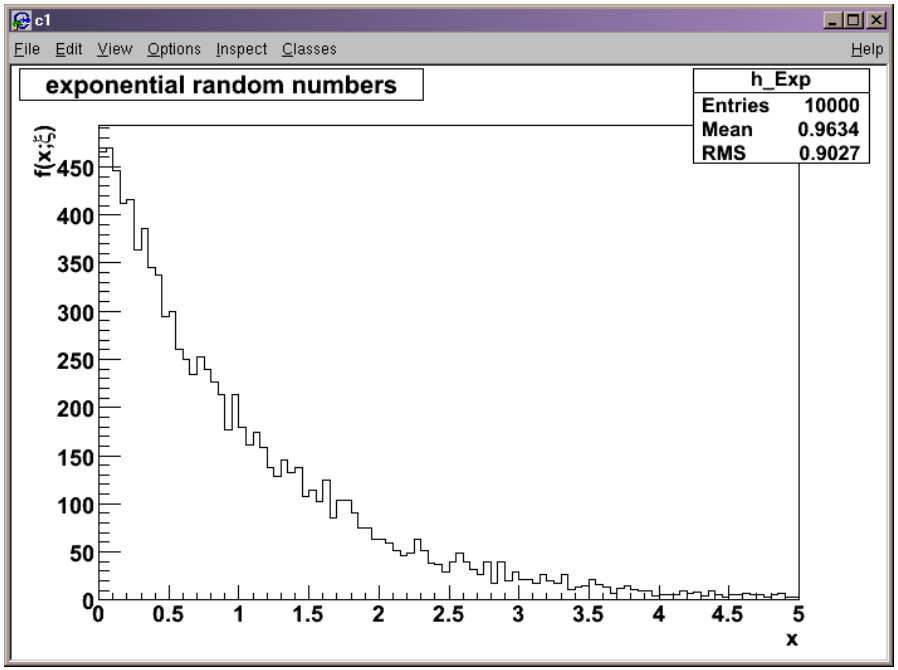


ROOT creates canvas.

To save plot: File, Save as, etc.

Better plots (store commands in a macro file)

```
// To execute, type .X plotHist.C
{
  TFile* f = new TFile("simpleMC.root");
  f->ls();
  TH1D* h1 = (TH1D*)f->Get("h_Exp");
  h1->SetXTitle("x");
  h1->SetYTitle("f(x;#xi)");
  h1->Draw();
}
```



Carry on with ROOT

Root home page: **root.cern.ch** (manual, tutorials, etc.)

Class definitions: **root.cern.ch/root/html/ClassIndex.html**
E.g. for TH1D: **root.cern.ch/root/html/TH1D.html**
(tick box "show inherited").

More ROOT lectures (links from course website):

Adrian Bevan (QMUL)
www.ph.qmul.ac.uk/~bevan/GCL/ROOT.pdf

Benno List (DESY)
www.desy.de/~blist/summerstudents/summer_lectures.2007cpp.html