Exercise/Lesson #10

Scientific Data Analysis Lab course

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Generation & Interpolation with an UML fit with RooFit

The `RooFit` macro `RooConvolutionExpNew` executes an UML fit of a distribution earlier generated (a txt file si also generated and can be used externally, for istance for GooFit, etc…)

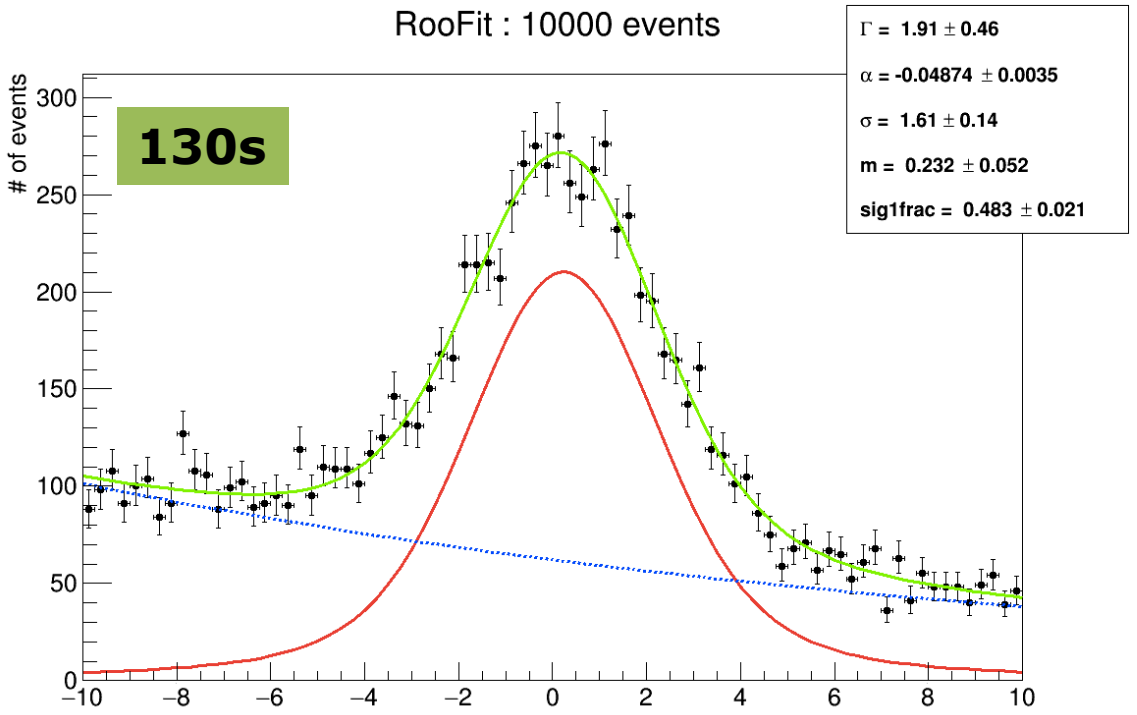
To execute the macro:

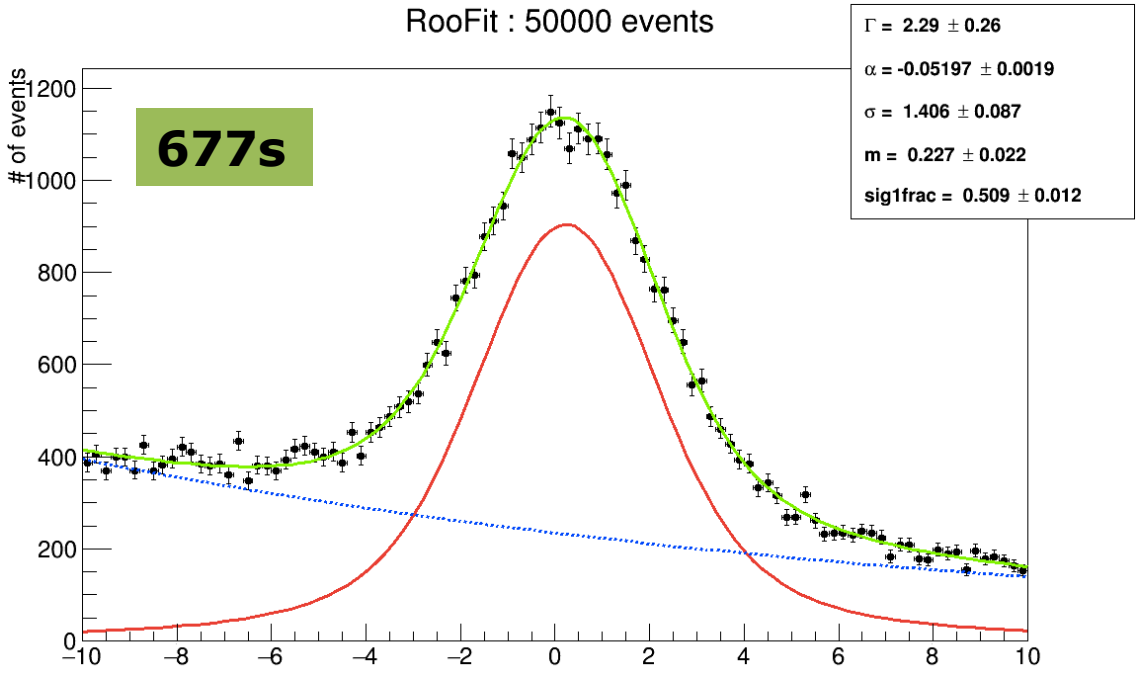
```
Root [0] .L RooConvolutionExpNew.C+
Root [1] RooConvolutionExp("#events","yes",#bins)

P.es. #events=10000 e #bins=80 (ci impiega 130s)
oppure #events=100000 e #bins=120 (ci impiega 1250s )
```

Note: the # of bins is settled only for representation purposes (the fit is still unbinned !)

Example of plots obtained in these 2 cases:





E' buona pratica confrontare il risultato dell'interpolazione con i valori dei parametri che sono stati messi in generazione. Si puo' verificare come l'accordo aumenti all'aumentare del # di eventi generati!

Una tabellina dei tempi per valutare le prestazioni;
il tempo impiegato si riferisce al solo fit (ma in ogni caso il tempo di generazione e' trascurabile rispetto a quello di fit):

#eventi	RooFit
10K	130s
100K	677s
1M	1250s

Here is the macro RooConvolutionExp.C:

Note: I have now switched to a new macro: RooConvolutionExpNew.C that is similar and we can discuss in the class.

```
#include "RooPolynomial.h"
#include "RooRealVar.h"
#include "RooBreitWigner.h"
#include "RooNumConvPdf.h"
#include "RooGaussian.h"
#include "RooExponential.h"
#include "RooDataSet.h"
#include "RooDataHist.h"
#include "RooAbsData.h"
#include "RooMinuit.h"
#include "RooPlot.h"
#include "RooChebychev.h"
#include "RooAddPdf.h"
#include "RooArgList.h"
#include "TH1F.h"
#include <vector>
#include "TCanvas.h"

#include <sys/time.h>
#include <sys/times.h>

using namespace RooFit; //Working in RooFit//

timeval startTime, stopTime, totalTime;
timeval startTimeRead, stopTimeRead, totalTimeRead;
clock_t startCPU, stopCPU;
clock_t startCPURead, stopCPURead;
tms startProc, stopProc;  //Struct time intervals in clock ticks//
tms startProcRead, stopProcRead;

void RooConvolutionExp(TString argv,int bins=200) {

  int events = atoi(argv.Data()); //converte stringa "numero" in numero --
  TString name = "";
  switch (events)
        {
         case 100: name = "100";
           break;
         case 1000: name = "1k";
           break;
         case 10000: name = "10k";
           break;
         case 100000: name = "100k";
           break;
         case 500000: name = "500k";
           break;
         case 1000000: name = "1M";
           break;
         case 5000000: name = "5M";
           break;
         case 10000000: name = "10M";
           break;
         case 50000000: name = "50M";
           break;
         case 100000000: name = "100M";
           break;
           //
        default: name = argv;
           break;
        }

  char bufferstring[256];
```

```
char bufferstring[256];

RooRealVar xvar("xvar", "", -10, 10);
xvar.setBins(bins);

// Breit Wigner Signal //
RooRealVar mean("m", "mean", 0.2, -1, 1);                      //Breit Wigner mean//
RooRealVar gamma("#Gamma", "gamma", 2, 0.1, 5);                //Breit Wigner width//
RooBreitWigner signal("BW", "BW signal", xvar, mean, gamma); //Breit Wigner pdf//

// Gaussian Resolution Function //
RooRealVar zero("zero","Gaussian resolution mean", 0.);                 // offset from mean
RooRealVar sigma("#sigma", "sigma", 1.5, 0.1, 5);                       //Gaussian sigma//
RooGaussian resol("resol", "Gaussian resolution", xvar, zero, sigma); //Gaussian pdf//

// Background //
RooRealVar alpha("#alpha","Exponential Parameter",-0.05,-2.0,0.0);
RooExponential bkg("Bkg","Bkg",xvar,alpha);

// Gaussian + BW convolution //
RooNumConvPdf convolution("convolution", "BW (X) gauss", xvar, signal , resol);

// TotalPdf = Gaussian + Bkg //
RooRealVar sigfrac("sig1frac","fraction of component 1 in signal",0.5,0.,1.) ;
RooAddPdf total("totalPDF", "totalPDF", RooArgList(convolution, bkg),sigfrac);

cout <<"\nGenerating " <<name <<" events\n" <<endl ;

////////////////////////////////////////////////////////////////////////////
// Generating data
////////////////////////////////////////////////////////////////////////////

RooDataSet* data = total.generate(xvar,events);
//
sprintf(bufferstring,"./txt_files/%d_events.txt",events);
data->write(bufferstring);

cout <<"\nFitting " <<name <<" events\n" <<endl ;
```

Generazione secondo il modello (pdf) *total*

Scrive la massa generata evento-per-evento nel file .txt esterno

```
cout <<"\nFitting " <<name <<" events\n" <<endl ;

////////////////////////////////////////////////////////////////////////////
// Fitting data
////////////////////////////////////////////////////////////////////////////


RooAbsReal* nll = total.createNLL(*data);

//Declare null (pointer) and assign -log(Likelyhood) to it, Likelihood -> convolution and *data//
RooMinuit min(*nll);
gettimeofday(&startTime, NULL);
startCPU = times(&startProc);
//Migrad Fit
min.migrad();

stopCPU = times(&stopProc);
gettimeofday(&stopTime, NULL);

////////////////////////////////////////////////////////////////////////////
// Fit result and data representation
////////////////////////////////////////////////////////////////////////////

TCanvas *foo = new TCanvas("RooCanvas","Roofit Canvas", 1200, 800);

RooPlot *frame = xvar.frame("") ;
sprintf(bufferstring," RooFit : %d events",events);
frame->SetTitle(bufferstring) ;
frame->SetYTitle("# of events") ;
data->plotOn(frame);
total.plotOn(frame,LineColor(kGreen));
total.plotOn(frame,Components(RooArgSet(convolution)),LineColor(kRed));
total.plotOn(frame,Components(RooArgSet(bkg)),LineColor(kBlue),LineStyle(kDashed));
total.paramOn(frame,  Layout(0.75,0.99,0.99));
frame->getAttText()->SetTextSize(0.028);

frame->Draw() ;
foo->SaveAs("plots/RooConvGen_"+name+".eps");
foo->SaveAs("plots/RooConvGen_"+name+".png");

// Print total fitting time
cout << "\n---------------------------------------------------------------" << endl ;
double myCPUc = (stopCPU - startCPU)*10000;
cout << "Total CPU time: " << (myCPUc / CLOCKS_PER_SEC);
cout << "\n---------------------------------------------------------------" << endl ;
cout << endl ;

}
```

PDF

dati generati (unbinned!!)

UML FIT

file esterni con il plot