What is ROOT? Why do we use it?

Answer:

ROOT does what physicists do:

It makes plots.
Another function to be fit

hist2
Nent = 10000
Mean = 6.714
RMS = 4.012
\[ \frac{\sin(y) \cdot \sin(x)}{x \cdot y} \]
Can you spot the pun in this plot?
The typical analysis task that you will be asked to do:

Take variables in an \textit{n-tuple}, perform some computations, and make \textit{histograms}.

So what is a \textit{histogram}, what is an \textit{n-tuple}, and how do we perform the computations?
Anatomy of a histogram

Properties of a histogram

- Name or Identifier
- Title (to be displayed on plot)
- Number of bins
- Lower bin limit
- Upper bin limit

A ROOT command that might be used to create this histogram:

```
TH1F hist("Example","Sample histogram",100,-3,3)
```
Don't forget the errors!

For simple histograms, the error in one bin is the square root of the number of events in that bin.
There's an art to histogram design...
Example 7
Nent = 1000
Mean = 0.0015
RMS = 0.9675
Anatomy of an n-tuple (a simple form of a ROOT Tree)

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<tr>
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<th>event</th>
<th>ebeam</th>
<th>px</th>
<th>py</th>
<th>pz</th>
<th>zv</th>
<th>chi2</th>
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<td>0.10</td>
<td>144.69</td>
<td>22.26</td>
<td>0.93</td>
</tr>
</tbody>
</table>

An n-tuple is an ordered list of numbers.

A ROOT Tree can be an ordered list of any collections of C++ objects.

Probably you'll only be asked to work with n-tuples this summer.
Why ROOT?

- It knows about n-tuples and histograms.
- It can handle large volumes of data (millions of physics events; files of gigabytes->terabytes in size).
- Multi-platform (Windows, Mac, many UNIX flavors)
- It's free.

But...

- You have to know some C++ in order to use ROOT effectively, in order to perform computations.
- What does C++ look like? Well...


```c
#define Analyze_cxx
#include "Analyze.h"
#include "TH2.h"
#include "TStyle.h"
#include "TCanvas.h"

void Analyze::Loop()
{
  // In a Root session, you can do:
  // Root > .L Analyze.C  
  // Root > Analyze t
  // Root > t.GetEntry(12); // Fill t data members with entry number 12
  // Root > t.Show();     // Show values of entry 12
  // Root > t.Show(16);   // Read and show values of entry 16
  // Root > t.Loop();    // Loop on all entries

  // This is the loop skeleton
  // To read only selected branches, Insert statements like:
  // METHOD1:
  // fChain->SetBranchStatus("*",0);  // disable all branches
  // fChain->SetBranchStatus("branchname",1); // activate branchname
  // METHOD2: replace line
  // fChain->GetEntry(i);  // read all branches
  // by  b_branchname->GetEntry(i); //read only this branch
  if (fChain == 0) return;

  Int_t nentries = fChain->GetEntries();

  Int_t nbytes = 0, nb = 0;
  for (Int_t jentry=0; jentry<nentries;jentry++) {
    Int_t ientry = LoadTree(jentry); //in case of a TChain, ientry is the entry number in the current file
    nb = fChain->GetEntry(jentry); nbytes += nb;
    // if (Cut(ientry) < 0) continue;
  }
}
```
Web Links
(the only part you should bother to write down)

All the documents you've seen (and will see) during the class today can be found at:

http://www.nevis.columbia.edu/~seligman/root-class/

ROOT and C++ links, including links to reference books on C++ and statistics, can be found at:

http://www.nevis.columbia.edu/~seligman/root-class/links.html
The Hands-on Course:
Basic Data Analysis using ROOT

ROOT basics

You will learn how to:
- look up ROOT command references
- plot a function
- histogram a variable
- fit a histogram
- create C++ code for an n-tuple
- get a variable from an n-tuple
- apply cuts

-- but not necessarily in this order!

There's lots of optional material to help turn you into a ROOT expert. Try to go over as much of it as you can.