Histograms

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No class on Friday, October 30. Instead, please review slides on TGraph and TMultiGraph and complete the posted assignment.

Deleting histograms from the memory

When a pointer is re-declared and set to a new memory location, the access to the location it was pointing to is lost. Memory is allocated but cannot be used. A message "... potential memory leak ..." is printed to the terminal. To print the list of all the objects:

```
gDirectory->GetList()->Print()
```

To delete all the objects:

```
gDirectory->GetList()->Delete()
```

To check if the object exists:

```
gDirectory->GetList()->FindObject("h1")
```

To delete an object:

```
gDirectory->GetList()->FindObject("h1")->Delete()
```

Histogram errors

```
1 h->GetBinError(nBin)
```

will return the error calculated as a sqrt(nEntries) in the given bin
To change the error to the sum of weights squared ($\sum w^2$) set the sumw2 option BEFORE filling in the histogram:

```
1 h->Sumw2() //or h->Sumw2(true), true is the default value
2 h->Sumw2(false) //clears the sumw2 option, error calculated as sqrt(
      nEntries) again
```

- Create an empty histogram h with 10 bins in the range 0, 10
- Fill in the bins from 0-4 with the bin number
- Change the way the errors are calculated by setting sumw2
- Fill in the bins 5-9 with the bin number
- Plot the histogram with error bars (use "e" option).
- Print out the error value for each of the bins.

Scale() and Rebin()

Histogram can be scaled by a value, i.e. the content of each bin will be multiplied by a value:

```
h->Scale(2.3)
```

The histogram can be re-binned, i.e. the size of the bins is increased by a factor and their content is summed into one bin

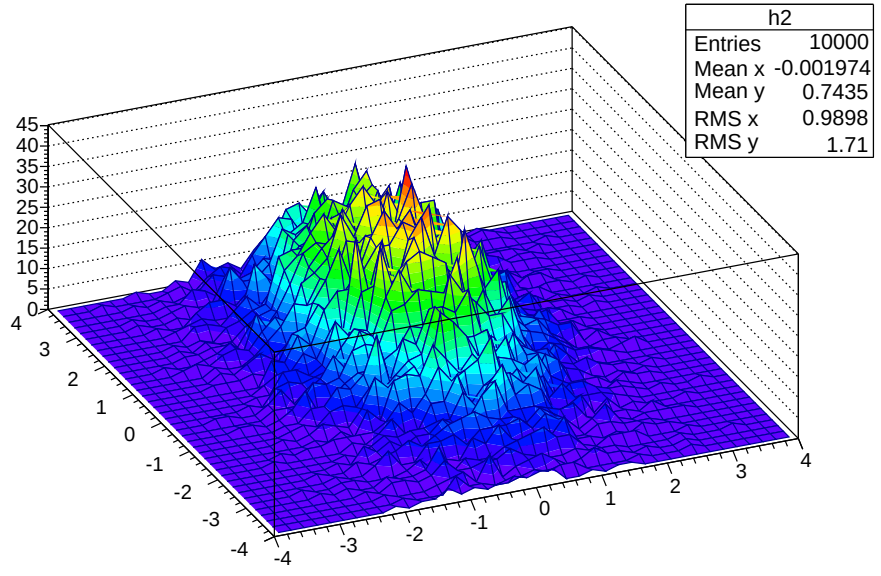
```
TH1F *h = new TH1F("h","",3000,0,3000)
h->Rebin(3)
//now h has 1000 bins in the region 0 to 3000
```

NOTE: the binning factor has to be an exact divider of the original number of bins (for this purpose having the number of bins in the powers of 2 is useful) NOTE2: rebinning is irreversible. To avoid overwriting the original histogram, save the rebinned one into another histogram:

```
TH1 * hReb = h->Rebin(4,"hReb");
```

2-D histograms

```
1 TH2D *h2 = new TH2D("h2", "Example 2D histo", 40,-4,4,40,-4,4);
2
3 for (int i = 0; i<10000; i++) {
4    double x = gRandom->Gaus(0,1);
5    double y = gRandom->Gaus(1,2);
6    h2->Fill(x,y);
7 }
8
9 h2->Draw(); //options colz, contour, lego(1-3), text, surf(1-5)
```



Projections and profiles

A 2D histogram can be projected to one of the axis:

```
1 h2->ProjectionX("hProjX",firstBin,lastBin)
```

The bins with the same x value are summed together.

A 2D histogram can be projected to one of the axis:

```
1 h2->ProfileX("hProfileX",firstBin,lastBin)
```

For all the bins with the same x value a mean of all the y values is calculated.

Problem 1: 1-D histograms

- Make a gaussian filled histogram h1 between 0 and 10 with 100 bins and 1000 entries with mean 5 and sigma 1.
- Make another histogram h2 uniformly distributed between 0 and 10 with 100 bins and 10000 entries.
- Add the two histogram into a new one using TH1::Add (hSignal = h1 + h2)
- Make another histogram hBgrd, containing a uniform distribution still with 100 bins but with 100000 entries. Normalize this histogram to have a total integral of 10000 using TH1::Scale.
- Subtract hBgrd from hSignal using TH1::Add (hDiff = hSum - hBgrd)
- Plot the result using the error option (hDiff->Draw("E")). Do the error make sense? If not, how can you get the correct bin errors

Problem 2: 2-D histograms

- Create a 2 dimensional histogram with x and y in the range [-5,5] and [-5,5] and 40 bins in each axis.
- Fill the histogram with correlated random normal numbers. To do this generate 2 random normal numbers (mean=0, sigma=1) u and w. Then use $x = u$ and $y = w + 0.5 * u$ for filling the histogram.
- Plot the histogram using plot option you prefer.
- After having filled the histogram, compute the correlation using TH1::GetCorrelationFactor.
- Make a projection of the 2-dimensional histogram on the y-axis.