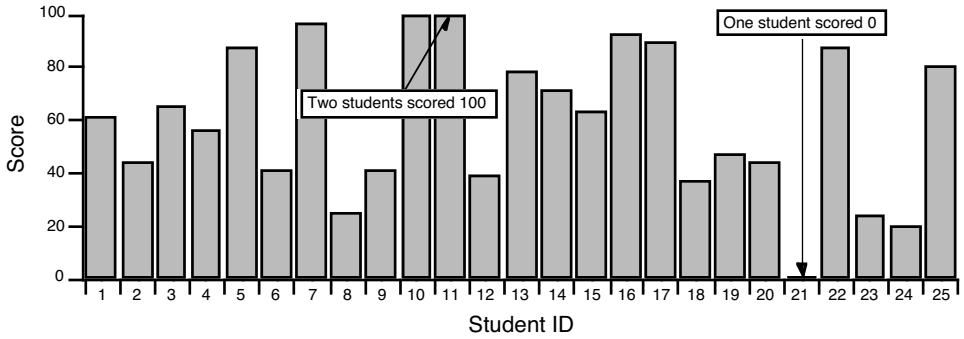
If you are working with large amounts of data and you are concerned about computation speed you might be able to take advantage of the /M flag that limits the calculation to the first order moments.

If you are working with 2D or 3D waves and you want to compute the statistics for a domain of an arbitrary shape you should use the **ImageStats** operation (see page V-414) with an ROI wave.

Histograms

A histogram totals the number of input values that fall within each of a number of value ranges (or "bins") usually of equal extent. For example, a histogram is useful for counting how many data values fall in each range of 0-10, 10-20, 20-30, etc. This calculation is often made to show how students performed on a test:



The usual use for a histogram in this case is to figure out how many students fall into certain numerical ranges, usually the ranges associated with grades A, B, C, and D. Suppose the teacher decides to divide the 0-100 range into 4 equal parts, one per grade. The **Histogram** operation (see page V-349) can be used to show how many students get each grade by counting how many students fall in each of the 4 ranges.

We start by creating a wave to hold the histogram output:

```
Make/N=4/D/O studentsWithGrade
```

Next we execute the Histogram command which we generated using the Histogram dialog:

```
Histogram/B={0,25,4} scores,studentsWithGrade
```

The /B flag tells Histogram to create four bins, starting from 0 with a bin width of 25. The first bin counts values from 0 up to but not including 25.

The Histogram operation analyzes the source wave (`scores`), and puts the histogram result into a destination wave (`studentsWithGrade`).

Let's create a text wave of `grades` to plot `studentsWithGrade` versus a grade letter in a category plot:

```
Make/O/T grades = {"D", "C", "B", "A"}
Display studentsWithGrade vs grades
SetAxis/A/E=1 left
```

Everything *looks* good in the category plot. Let's double-check that all the students made it into the bins:

```
Print sum(studentsWithGrade)
  23
```

There are two missing students. They are ones who scored 100 on the test. The four bins we defined are actually:

Bin 1:	0 - 24.99999
Bin 2:	25 - 49.99999
Bin 3:	50 - 74.99999
Bin 4:	75 - 99.99999

The problem is that the test scores actually encompass 101 values, not 100. To include the perfect scores in the last bin, we could add a small number such as 0.001 to the bin width:

Bin 1:	0 - 25.00999
Bin 2:	25.001 - 49.00199
Bin 3:	50.002 - 74.00299
Bin 4:	75.003 - 100.0399

The students who scored 25, 50 or 75 would be moved down one grade, however. Perhaps the best solution is to add another bin for perfect scores:

```
Make/O/T grades= {"D", "C", "B", "A", "A+"}
Histogram/B={0,25,5} scores,studentsWithGrade
```

For information on plotting a histogram, see Chapter II-14, **Category Plots** and **Graphing Histogram Results** on page III-127.

This example was intended to point out the care needed when choosing the histogram binning. Our example used "manual binning".

The Histogram operation provides five ways to set binning. They correspond to the radio buttons in the Histogram dialog:

Bin Mode	What It Does
Manual bins	Sets number of points and X scaling of the destination (output) wave based on parameters that you explicitly specify.
Auto-set bins	Sets X scaling of destination wave to cover the range of values in the **source** wave. Does not change the number of points (bins) in the destination wave. Thus, you must set the number of destination wave points before computing the histogram. When using the Histogram dialog, if you select Make New Wave or Auto from the Output Wave menu, the dialog must be told how many points the new wave should have. It displays the Number of Bins box to let you specify the number.
Set bins from destination wave	Does not change the X scaling or the number of points in the destination wave. Thus, you need to set the X scaling and number of points of the destination wave before computing the histogram. When using the Histogram dialog, the Set from destination wave radio button is only available if you choose Select Existing Wave from the Output Wave menu.
Auto-set bins: 1+log2(N)	Examines the input data and sets the number of bins based on the number of input data points. Sets the bin range the same as if Auto-set bin range were selected.
Auto-set bins: 3.49*Sdev*N^-1/3	Examines the input data and sets the number of bins based on the number of input data points and the standard deviation of the data. Sets the bin range the same as if Auto-set bin range were selected.
Freedman-Diaconis method	Sets the optimal bin width to $binWidth = 2 * IQR * N^{-1/3}$ where IQR is the interquartile distance (see StatsQuantiles) and the bins are evenly-distributed between the minimum and maximum values. Added in Igor Pro 7.00.