One problem with these functions is that they can not be used if the given range of data has missing values (NaNs). See **Dealing with Missing Values** on page III-112 for details.

X Ranges and the Mean, faverage, and area Functions

The X range input for the mean, faverage and area functions are optional. Thus, to include the entire wave you don't have to specify the range:

```
Make/N=10 wave=2; Edit wave.xy   // X ranges from 0 to 9
Print area(wave)                 // entire X range, and no more
18
```

Sometimes, in programming, it is not convenient to determine whether a range is beyond the ends of a wave. Fortunately, these functions also accept X ranges that go beyond the ends of the wave.

```
Print area(wave, 0, 9)           // entire X range, and no more
18
```

You can use expressions that evaluate to a range beyond the ends of the wave:

```
Print leftx(wave),rightx(wave)
0  10
Print area(wave,leftx(wave),rightx(wave))      // entire X range, and more
18
```

or even an X range of ±×:

```
Print area(wave, -Inf, Inf)  // entire X range of the universe
18
```

Finding the Mean of Segments of a Wave

Under **Analysis Programming** on page III-170 is a function that finds the mean of segments of a wave where you specify the length of the segments. It creates a new wave to contain the means for each segment.

Area for XY Data

To compute the area of a region of data contained in an XY pair of waves, use the **areaXY** function (see page V-41). There is also an XY version of the faverage function; see **faverageXY** on page V-218.

In addition you can use the AreaXYBetweenCursors WaveMetrics procedure file which contains the AreaXYBetweenCursors and AreaXYBetweenCursorsLessBase procedures. For instructions on loading the procedure file, see **WaveMetrics Procedures Folder** on page II-32. Use the **Info Panel and Cursors** to delimit the X range over which to compute the area. AreaXYBetweenCursorsLessBase removes a simple trapezoidal baseline - the straight line between the cursors.

Wave Statistics

The **WaveStats** operation (see page V-1082) computes various descriptive statistics relating to a wave and prints them in the history area of the command window. It also stores the statistics in a series of special variables or in a wave so you can access them from a procedure.

The statistics printed and the corresponding special variables are:

Variable	Meaning
V_npnts	Number of points in range excluding points whose value is NaN or INF.
V_numNaNs	Number of NaNs.
V_numINFs	Number of INFs.
V_avg	Average of data values.

Variable	Meaning
V_sum	Sum of data values.
V_sdev	Standard deviation of data values, $\sigma = \sqrt{\frac{1}{V\_npnts-1}\sum(Y_i - V\_avg)^2}$ "Variance" is V_sdev^2.
V_sem	Standard error of the mean $sem = \frac{\sigma}{\sqrt{V\_npnts}}$
V_rms	RMS (Root Mean Square) of Y values $= \sqrt{\left(\frac{1}{V\_npnts}\sum Y_i^2\right)}$
V_adev	Average deviation $= \frac{1}{V\_npnts}\sum_{i=0}^{V\_npnts-1}\left\|x_i - \bar{x}\right\|$
V_skew	Skewness $= \frac{1}{V\_npnts}\sum_{i=0}^{V\_npnts-1}\left[\frac{x_i - \bar{x}}{\sigma}\right]^3$
V_kurt	Kurtosis $= \frac{1}{V\_npnts}\sum_{i=0}^{V\_npnts-1}\left[\frac{x_i - \bar{x}}{\sigma}\right]^4 - 3$
V_minloc	X location of minimum data value.
V_min	Minimum data value.
V_maxloc	X location of maximum data value.
V_max	Maximum data value.
V_minRowLoc	Row containing minimum data value.
V_maxRowLoc	Row containing maximum data value.
V_minColLoc	Column containing minimum data value (2D or higher waves).
V_maxColLoc	Column containing maximum data value (2D or higher waves).
V_minLayerLoc	Layer containing minimum data value (3D or higher waves).
V_maxLayerLoc	Layer containing maximum data value (3D or higher waves).
V_minChunkLoc	Chunk containing minimum v value (4D waves only).
V_maxChunkLoc	Chunk containing maximum data value (4D waves only).
V_startRow	The unscaled index of the first row included in caculating statistics.
V_endRow	The unscaled index of the last row included in caculating statistics.
V_startCol	The unscaled index of the first column included in calculating statistics. Set only when /RMD is used.

Variable	Meaning
V_endCol	The unscaled index of the last column included in calculating statistics. Set only when /RMD is used.
V_startLayer	The unscaled index of the first layer included in calculating statistics. Set only when /RMD is used.
V_endLayer	The unscaled index of the last layer included in calculating statistics. Set only when /RMD is used.
V_startChunk	The unscaled index of the first chunk included in calculating statistics. Set only when /RMD is used.
V_endChunk	The unscaled index of the last chunk included in calculating statistics. Set only when /RMD is used.

To use the WaveStats operation, choose Wave Stats from the Statistics menu.

Igor ignores NaNs and INFs in computing the average, standard deviation, RMS, minimum and maximum. NaNs result from computations that have no defined mathematical meaning. They can also be used to represent missing values. INFs result from mathematical operations that have no finite value.

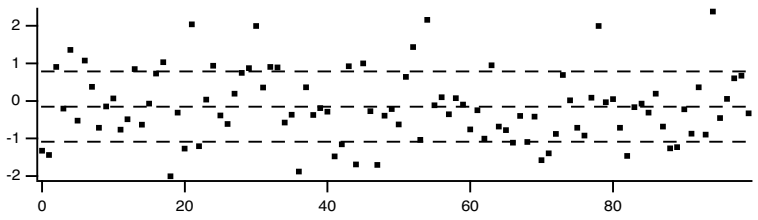
This procedure illustrates the use of WaveStats. It shows the average and standard deviation of a source wave, assumed to be displayed in the top graph. It draws lines to indicate the average and standard deviation.

```
Function ShowAvgStdDev(source)
   Wave source                                          // source waveform

   Variable left=leftx(source),right=rightx(source)    // source X range
   WaveStats/Q source
   SetDrawLayer/K ProgFront
   SetDrawEnv xcoord=bottom,ycoord=left,dash= 7
   DrawLine left, V_avg, right, V_avg                   // show average
   SetDrawEnv xcoord=bottom,ycoord=left,dash= 7
   DrawLine left, V_avg+V_sdev, right, V_avg+V_sdev    // show +std dev
   SetDrawEnv xcoord=bottom,ycoord=left,dash= 7
   DrawLine left, V_avg-V_sdev, right, V_avg-V_sdev    // show -std dev
   SetDrawLayer UserFront
End
```

You could try this function using the following commands.

```
Make/N=100 wave0 = gnoise(1)
Display wave0; ModifyGraph mode(wave0)=2, lsize(wave0)=3
ShowAvgStdDev(wave0)
```



When you use WaveStats with a complex wave, you can choose to compute the same statistics as above for the real, imaginary, magnitude and phase of the wave. By default WaveStats only computes the statistics for the real part of the wave. When computing the statistics for other components, the operation stores the results in a multidimensional wave M_WaveStats.