ALLAN STANDARD DEVIATION PLOT

PURPOSE

Generates an Allan standard deviation plot in order to examine the low-frequency component of a spectrum of an equi-spaced time series, and to estimate the exponent in a low-frequency power-law spectral model.

DESCRIPTION

The Allan standard deviation plot is a graphical data analysis technique for examining the low-frequency component of a time series. The horizontal axis is the subsample size (up to N/2). The vertical axis is the Allan standard deviation (ASD(K)), which is the standard deviation of the squared deltas as defined below. For subsample size 1:

delta1 = x(1)-x(2)
delta2 = x(3)-x(4)
delta3 = x(5)-x(6)
...
deltan = x(n-1)-x(n)

For subsample size 2:

delta1 = (x(1)+x(2))-(x(3)+x(4))
delta2 = (x(5)+x(6))-(x(7)+x(8))
...

For subsample size 3:

delta1 = (x(1)+x(2)+x(3))-(x(4)+x(5)+x(6))
delta2 = (x(7)+x(8)+x(9))-(x(10)+x(11)+x(12))
...

The Allan standard deviation plot is usually viewed on a loglog scale. A common frequency domain model for the spectrum S(w) of a low-frequency time series is the power-law:

$$S(w) = w^{\alpha}$$

There is a one-to-one correspondence between the slope of the loglog spectrum (the α) and the slope of the loglog Allan standard deviation plot:

Time Series Model	Slope of Loglog Spectrum α	Slope of Loglog ASD Plot $(-\alpha-1)$
Random Walk	-2	1
Flicker	-1	0
White Noise	0	-1
Super Flicker	1	-2
Super White	2	-3

If one has a time series with a dominant low-frequency component, then the Allan standard deviation plot is a useful tool for assessing the nature of the low-frequency component and for estimating the power (α) of the power-law spectral power-law model. The slope of the Allan standard deviation plot indicates the nature of the underlying time series model.

The response variable must have at least 3 elements.

SYNTAX

ALLAN STANDARD DEVIATION PLOT <y1> <SUBSET/EXCEPT/FOR qualification>
where <y1> is a response variable;
and where the <SUBSET/EXCEPT/FOR qualification> is optional.

EXAMPLES

ALLAN STANDARD DEVIATION PLOT Y
ASD PLOT Y

NOTE 1

The Allan variance plot and the Allan standard deviation plot have equivalent information content (and differ only by a factor of 2). The Allan variance plot is more heavily used than the Allan standard deviation plot.

DEFAULT
None

SYNONYMS
ASD PLOT

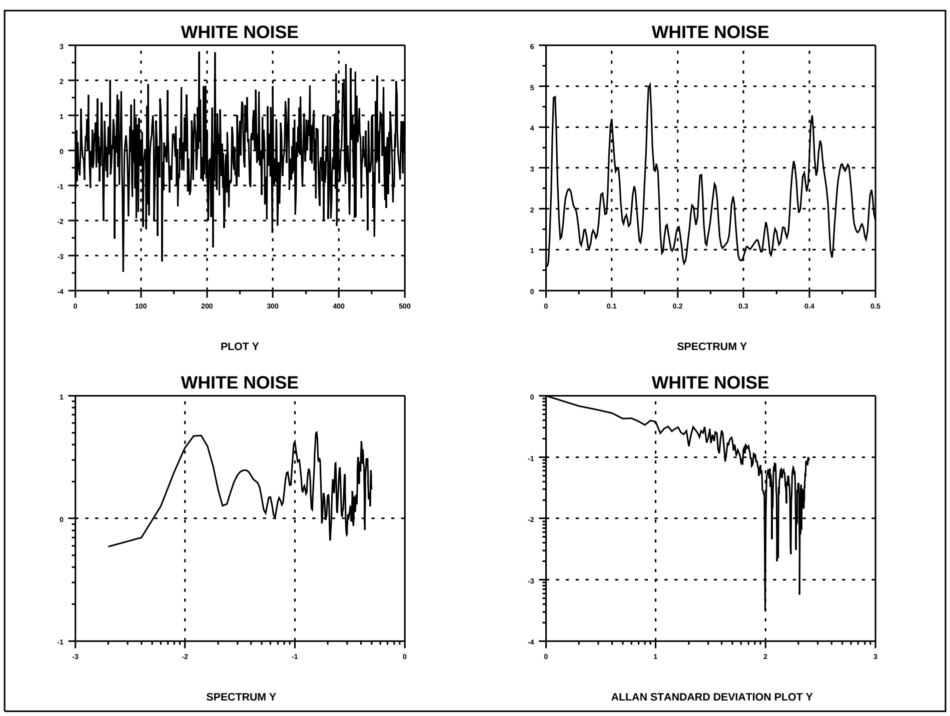
RELATED COMMANDS
SPECTRAL PLOT	=	Generates a spectral plot.
ALLAN VARIANCE PLOT	=	Generate an Allan variance plot.

REFERENCE
Dave Allan, NIST in Boulder

APPLICATIONS
Frequency Time Series Analysis

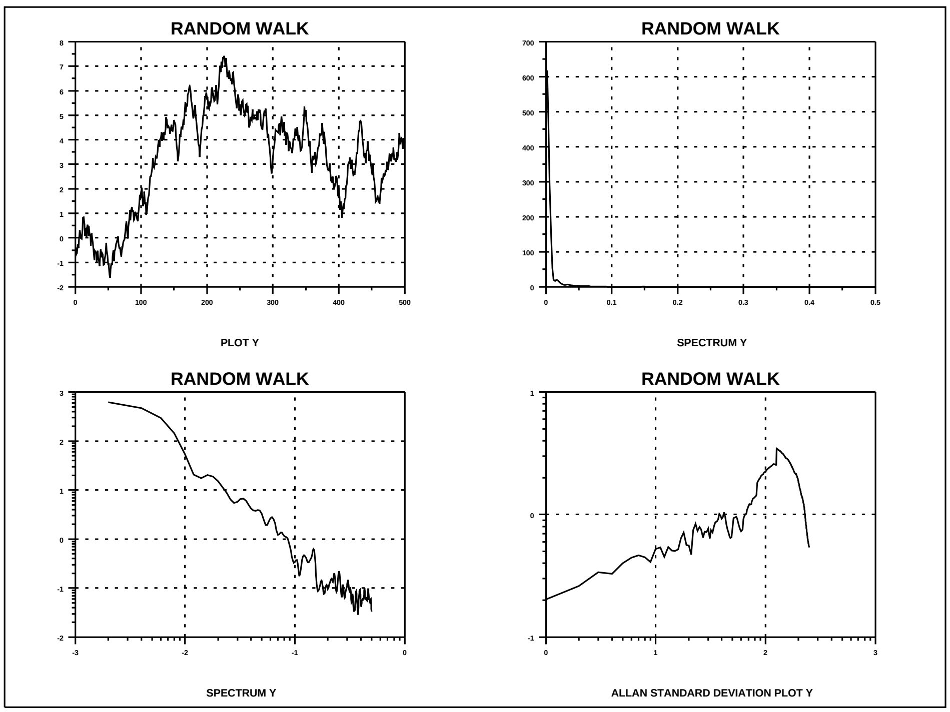
IMPLEMENTATION DATE
87/1

PROGRAM 1
```
. THIS IS AN EXAMPLE OF AN ALLAN SD PLOT
. FOR WHITE NOISE DATA S(W) = W**0
. (THUS THE LOGLOG SPECTRUM HAS SLOPE 0 AND
. AND THE ALLAN SD PLOT HAS SLOPE (-(0)-1) = -1
LET Y = NORMAL RANDOM NUMBERS FOR I = 1 1 500
TITLE WHITE NOISE
MULTIPLOT 2 2; MULTIPLOT CORNER COORDINATES 0 0 100 100
GRID ON; X3LABEL AUTOMATIC
PLOT Y; SPECTRUM Y
LOGLOG; SPECTRUM Y; ALLAN STANDARD DEVIATION PLOT Y
END OF MULTIPLOT
```



PROGRAM 2

```
. THIS IS AN EXAMPLE OF AN ALLAN SD PLOT
. FOR RANDOM WALK DATA S(W) = W**(-2)
. (THUS THE LOGLOG SPECTRUM HAS SLOPE -2 AND
. AND THE ALLAN VARIANCE PLOT HAS SLOPE (-(-2)-1) = 1
SKIP 25
READ RANDWALK.DAT Y
TITLE RANDOM WALK
MULTIPLOT 2 2; MULTIPLOT CORNER COORDINATES 0 0 100 100
GRID ON
X3LABEL AUTOMATIC
PLOT Y
SPECTRUM Y
LOGLOG
SPECTRUM Y
ALLAN STANDARD DEVIATION PLOT Y
END OF MULTIPLOT
```



PROGRAM 3

```
. THIS IS AN EXAMPLE OF AN ALLAN SD PLOT
. FOR FLICKER NOISE DATA S(W) = W**(-1)
. (THUS THE LOGLOG SPECTRUM HAS SLOPE -1 AND
. AND THE ALLAN VARIANCE PLOT HAS SLOPE (-(-1)-1) = 0
SKIP 25
READ FLICKER.DAT Y
TITLE FLICKER DATA
MULTIPLOT 2 2; MULTIPLOT CORNER COORDINATES 0 0 100 100
GRID ON
X3LABEL AUTOMATIC
PLOT Y
SPECTRUM Y
LOGLOG
SPECTRUM Y
ALLAN STANDARD DEVIATION PLOT Y
END OF MULTIPLOT
```