

NAG Library Routine Document

G13AUF

Note: before using this routine, please read the Users' Note for your implementation to check the interpretation of *bold italicised* terms and other implementation-dependent details.

1 Purpose

G13AUF calculates the range (or standard deviation) and the mean for groups of successive time series values. It is intended for use in the construction of range-mean plots.

2 Specification

SUBROUTINE G13AUF (N, Z, M, NGRPS, RS, Y, MEAN, IFAIL)

INTEGER N, M, NGRPS, IFAIL
 REAL (KIND=nag_wp) Z(N), Y(NGRPS), MEAN(NGRPS)
 CHARACTER(1) RS

3 Description

Let Z_1, Z_2, \dots, Z_n denote n successive observations in a time series. The series may be divided into groups of m successive values and for each group the range or standard deviation (depending on a user-supplied option) and the mean are calculated. If n is not a multiple of m then groups of equal size m are found starting from the end of the series of observations provided, and any remaining observations at the start of the series are ignored. The number of groups used, k , is the integer part of n/m . If you wish to ensure that no observations are ignored then the number of observations, n , should be chosen so that n is divisible by m .

The mean, M_i , the range, R_i , and the standard deviation, S_i , for the i th group are defined as

$$M_i = \frac{1}{m} \sum_{j=1}^m Z_{l+m(i-1)+j}$$

$$R_i = \max_{1 \leq j \leq m} \{Z_{l+m(i-1)+j}\} - \min_{1 \leq j \leq m} \{Z_{l+m(i-1)+j}\}$$

and

$$S_i = \sqrt{\left(\frac{1}{m-1}\right) \sum_{j=1}^m (Z_{l+m(i-1)+j} - M_i)^2}$$

where $l = n - km$, the number of observations ignored.

For seasonal data it is recommended that m should be equal to the seasonal period. For non-seasonal data the recommended group size is 8.

A plot of range against mean or of standard deviation against mean is useful for finding a transformation of the series which makes the variance constant. If the plot appears random or the range (or standard deviation) seems to be constant irrespective of the mean level then this suggests that no transformation of the time series is called for. On the other hand an approximate linear relationship between range (or standard deviation) and mean would indicate that a log transformation is appropriate. Further details may be found in either Jenkins (1979) or McLeod (1982).

You have the choice of whether to use the range or the standard deviation as a measure of variability. If the group size is small they are both equally good but if the group size is fairly large (e.g., $m = 12$ for monthly data) then the range may not be as good an estimate of variability as the standard deviation.

4 References

Jenkins G M (1979) *Practical Experiences with Modelling and Forecasting Time Series* GJP Publications, Lancaster

McLeod G (1982) *Box–Jenkins in Practice. 1: Univariate Stochastic and Single Output Transfer Function/Noise Analysis* GJP Publications, Lancaster

5 Parameters

- 1: N – INTEGER *Input*
On entry: n , the number of observations in the time series.
Constraint: $N \geq M$.
- 2: Z(N) – REAL (KIND=nag_wp) array *Input*
On entry: $Z(t)$ must contain the t th observation Z_t , for $t = 1, 2, \dots, n$.
- 3: M – INTEGER *Input*
On entry: m , the group size.
Constraint: $M \geq 2$.
- 4: NGRPS – INTEGER *Input*
On entry: k , the number of groups.
Constraint: $NGRPS = \text{int}(N/M)$.
- 5: RS – CHARACTER(1) *Input*
On entry: indicates whether ranges or standard deviations are to be calculated.
 RS = 'R'
 Ranges are calculated.
 RS = 'S'
 Standard deviations are calculated.
Constraint: RS = 'R' or 'S'.
- 6: Y(NGRPS) – REAL (KIND=nag_wp) array *Output*
On exit: $Y(i)$ contains the range or standard deviation, as determined by RS, of the i th group of observations, for $i = 1, 2, \dots, k$.
- 7: MEAN(NGRPS) – REAL (KIND=nag_wp) array *Output*
On exit: $\text{MEAN}(i)$ contains the mean of the i th group of observations, for $i = 1, 2, \dots, k$.
- 8: IFAIL – INTEGER *Input/Output*
On entry: IFAIL must be set to 0, -1 or 1. If you are unfamiliar with this parameter you should refer to Section 3.3 in the Essential Introduction for details.
 For environments where it might be inappropriate to halt program execution when an error is detected, the value -1 or 1 is recommended. If the output of error messages is undesirable, then the value 1 is recommended. Otherwise, if you are not familiar with this parameter, the recommended value is 0. **When the value -1 or 1 is used it is essential to test the value of IFAIL on exit.**
On exit: IFAIL = 0 unless the routine detects an error or a warning has been flagged (see Section 6).

6 Error Indicators and Warnings

If on entry `IFAIL = 0` or `-1`, explanatory error messages are output on the current error message unit (as defined by `X04AAF`).

Errors or warnings detected by the routine:

`IFAIL = 1`

On entry, $N < M$,
or $M < 2$,
or $NGRPS \neq$ integer part of N/M .

`IFAIL = 2`

On entry, `RS` is not equal to 'R' or 'S'.

7 Accuracy

The computations are believed to be stable.

8 Further Comments

The time taken by `G13AUF` is approximately proportional to n .

If you wish to obtain a plot of the group ranges or standard deviations against the group means then `G01AGF` may be used. The plot is output to the unit defined by `X04ABF`. You should note that `G01AGF` sorts the data to be plotted on the y axis (in this case the ranges or standard deviations). If required you may use `M01EAF` to re-arrange the data into their original order.

9 Example

The following program produces the statistics for a range-mean plot for a series of 100 observations divided into groups of 8.

9.1 Program Text

```

Program g13aufe

!      G13AUF Example Program Text

!      Mark 24 Release. NAG Copyright 2012.

!      .. Use Statements ..
Use nag_library, Only: g01agf, g13auf, nag_wp, x04abf
!      .. Implicit None Statement ..
Implicit None
!      .. Parameters ..
Integer, Parameter          :: iset = 1, nin = 5, nout = 6
!      .. Local Scalars ..
Integer                     :: ifail, m, n, nadv, ngrps, nstepx,    &
                             nstepy
!      .. Local Arrays ..
Real (Kind=nag_wp), Allocatable :: mean(:), y(:), z(:)
Integer, Allocatable          :: isort(:)
!      .. Executable Statements ..
Write (nout,*) 'G13AUF Example Program Results'
Write (nout,*)

!      Skip heading in data file
Read (nin,*)

!      Read in the problem size
Read (nin,*) n, m

```

```

ngrps = n/m
Allocate (z(n),y(ngrps),mean(ngrps),isort(ngrps))
! Read in data
Read (nin,*) z(1:n)
! Calculate summary statistics
ifail = 0
Call g13auf(n,z,m,ngrps,'RANGE',y,mean,ifail)
! Set the advisory channel to NOUT for the plot
nadv = nout
Call x04abf(iset,nadv)
! Read in parameters controlling scatter plot
Read (nin,*) nstepx, nstepy
! Display title
Write (nout,*) '                               Range-mean plot'
Write (nout,*)
Flush (nout)
! Produce scatter plot
Call g01agf(mean,y,ngrps,isort,nstepx,nstepy,ifail)

End Program g13aufe

```

9.2 Program Data

```

G13AUF Example Program Data
100 8                               : N,M
101.0 82.0 66.0 35.0 31.0
   6.0 20.0 90.0 154.0 125.0
  85.0 68.0 38.0 23.0 10.0
  24.0 83.0 133.0 131.0 118.0
  90.0 67.0 60.0 47.0 41.0
  21.0 16.0 6.0 4.0 7.0
  14.0 34.0 45.0 43.0 49.0
  42.0 28.0 10.0 5.0 2.0
   0.0 1.0 3.0 12.0 14.0
  35.0 47.0 41.0 30.0 24.0
  16.0 7.0 4.0 2.0 8.0
  13.0 36.0 50.0 62.0 67.0
  72.0 48.0 29.0 8.0 13.0
  57.0 122.0 139.0 103.0 86.0
  63.0 37.0 26.0 11.0 15.0
  40.0 62.0 98.0 124.0 96.0
  65.0 64.0 54.0 39.0 21.0
   7.0 4.0 23.0 53.0 94.0
  96.0 77.0 59.0 44.0 47.0
  30.0 16.0 7.0 37.0 74.0       : End of X
60 35                           : NSTEPX,NSTEPY

```

9.3 Program Results

G13AUF Example Program Results



