NAG Fortran 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

Z(N), Y(NGRPS), MEAN(NGRPS)

CHARACTER*1

RS

3 Description

Let Z_1, Z_2, \ldots, 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 the user wishes 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

$$\begin{split} M_i &= \frac{1}{m} \!\! \sum_{j=1}^m \!\! Z_{l+m(i-1)+j} \\ R_i &= \max_{1 \leq j \leq m} \{ Z_{l+m(i-1)+j} \} - \min_{1 \leq j \leq m} \{ Z_{l+m(i-1)+j} \} \end{split}$$

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 nonseasonal 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).

The user has 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.

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Output

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: the number of observations in the time series, n.

Constraint: $N \ge M$.

2: Z(N) - real array Input

On entry: Z(t) must contain the tth observation Z_t , for t = 1, 2, ..., n.

3: M – INTEGER Input

On entry: the group size, m.

Constraint: $M \ge 2$.

4: NGRPS – INTEGER Input

On entry: the number of groups, k.

Constraint: NGRPS = INT(N/M).

5: RS – CHARACTER*1 Input

On entry: indicates whether ranges or standard deviations are to be calculated.

If RS = R', then ranges are calculated.

If RS = 'S', then standard deviations are calculated.

Constraint: RS = R' or 'S'.

6: Y(NGRPS) – *real* array

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, ..., k.

7: MEAN(NGRPS) – *real* array *Output*

On exit: MEAN(i) contains the mean of the ith group of observations for i = 1, 2, ..., k.

8: IFAIL – INTEGER Input/Output

On entry: IFAIL must be set to 0, -1 or 1. Users who are unfamiliar with this parameter should refer to Chapter P01 for details.

On exit: IFAIL = 0 unless the routine detects an error (see Section 6).

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, for users 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.

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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:

```
\begin{split} \text{IFAIL} &= 1 \\ &\quad \text{On entry, N} < \text{M,} \\ &\quad \text{or} \qquad \text{M} < 2, \\ &\quad \text{or} \qquad \text{NGRPS} \neq \text{integer part of N/M.} \end{split} \text{IFAIL} &= 2 \\ &\quad \text{On entry, RS is not equal to 'R' or 'S'.} \end{split}
```

7 Accuracy

The computations are believed to be stable.

8 Further Comments

The time taken by the routine is approximately proportional to n.

If the user wishes 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. The user should note that G01AGF sorts the data to be plotted on the y axis (in this case the ranges or standard deviations). If required the user may use M01EAF to re-arrange the data into their original order.

9 Example

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

9.1 Program Text

Note: the listing of the example program presented below uses *bold italicised* terms to denote precision-dependent details. Please read the Users' Note for your implementation to check the interpretation of these terms. As explained in the Essential Introduction to this manual, the results produced may not be identical for all implementations.

```
G13AUF Example Program Text
Mark 14 Release. NAG Copyright 1989.
.. Parameters ..
                 NIN, NOUT
INTEGER
                 (NIN=5, NOUT=6)
PARAMETER
                NMAX, KMAX
INTEGER
                 (NMAX=100,KMAX=NMAX/2)
PARAMETER
.. Local Scalars ..
                I, IFAIL, K, M, N, NSTEPX, NSTEPY
INTEGER
.. Local Arrays ..
                MEAN(KMAX), RANGE(KMAX), Z(NMAX)
real
INTEGER
                 ISORT(KMAX)
.. External Subroutines .
                GO1AGF, G13AUF, XO4ABF
.. Executable Statements ..
WRITE (NOUT,*) 'G13AUF Example Program Results'
Skip heading in data file
READ (NIN, *)
CALL X04ABF(1, NOUT)
READ (NIN,*) N, M
IF (N.GE.M .AND. N.LE.NMAX .AND. M.GE.1) THEN
   READ (NIN, \star) (Z(I), I=1, N)
   WRITE (NOUT, *)
   WRITE (NOUT, *)
```

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```
+ ' Range-mean plot'
    WRITE (NOUT,*)
    K = N/M
    IFAIL = 0

*
    CALL G13AUF(N,Z,M,K,'RANGE',RANGE,MEAN,IFAIL)

*
    Produce a scatterplot of range against mean or standard deviation against mean.
    NSTEPX = 60
    NSTEPY = 35

*
    CALL G01AGF(MEAN,RANGE,K,ISORT,NSTEPX,NSTEPY,IFAIL)

*
END IF
    STOP
    END
```

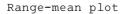
9.2 Program Data

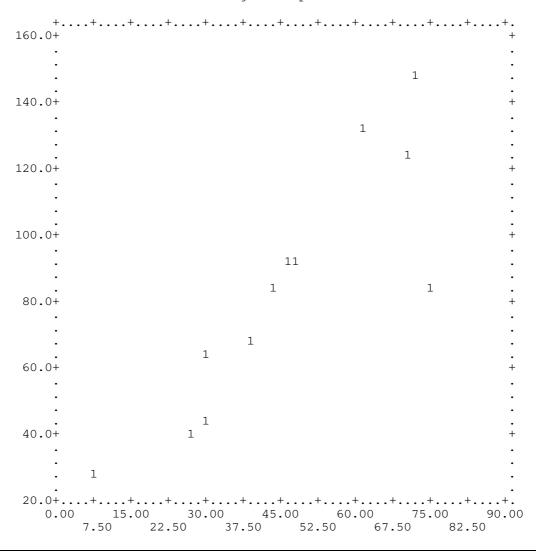
```
G13AUF Example Program Data
100 8 : N, no. of obs in time series, M, no. of obs in each group
101 82 66 35 31
                   6 20 90 154 125
        38 23
60 47
 85 68
               10 24 83 133 131 118
 90
     67
                41
                   21
                       16
        45 43 49 42
     34
                      28
                          10
 14
                              5
                                  2
        3 12
               14
                  35
                      47 41 30 24
     7
           2
                   13 36 50 62
 16
        4
               8
                                 67
 72
     48
        29
            8
               13
                   57 122 139 103
                                  86
               15
        26 11
 63
     37
                          98 124
                   40
                      62
                                 96
                   7
 65
    64
        54 39 21
                       4
                          23 53
                                 94
        59 44 47 30 16
                          7 37 74 : End of time series
 96
    77
```

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9.3 Program Results

G13AUF Example Program Results





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