NAG Toolbox for MATLAB

g13au

1 Purpose

g13au 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 Syntax

```
[y, mean, ifail] = g13au(z, m, rs, 'n', n)
```

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 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 ith group are defined as

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

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

and

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

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.

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

5.1 Compulsory Input Parameters

1: **z(n) – double array**

$\mathbf{z}(t)$ must contain the tth observation Z_t, for $t = 1, 2, \ldots, n$.

2: **m – int32 scalar**

m, the group size.

Constraint: $\mathbf{m} \geq 2$.

3: **rs – string**

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'.

5.2 Optional Input Parameters

1: **n – int32 scalar**

Default: The dimension of the array **z**.

n, the number of observations in the time series.

Constraint: $\mathbf{n} \geq \mathbf{m}$.

5.3 Input Parameters Omitted from the MATLAB Interface

ngrps

5.4 Output Parameters

1: **y(ngrps) – double array**

$\mathbf{y}(i)$ contains the range or standard deviation, as determined by **rs**, of the ith group of observations, for $i = 1, 2, \ldots, k$.

2: **mean(ngrps) – double array**

$\mathbf{mean}(i)$ contains the mean of the ith group of observations, for $i = 1, 2, \ldots, k$.

3: **ifail – int32 scalar**

0 unless the function detects an error (see Section 6).

6 Error Indicators and Warnings

Errors or warnings detected by the function:

ifail = 1

On entry, $\mathbf{n} < \mathbf{m}$,
or $\mathbf{m} < 2$,
or **ngrps** $\neq$ integer part of $\mathbf{n}/\mathbf{m}$.

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 g13au is approximately proportional to n.

If you wish to obtain a plot of the group ranges or standard deviations against the group means then g01ag may be used. The plot is output to the unit defined by x04ab. You should note that g01ag sorts the data to be plotted on the y axis (in this case the ranges or standard deviations). If required you may use m01ea to re-arrange the data into their original order.

9 Example

```
z = [101;
     82;
     66;
     35;
     31;
     6;
     20;
     90;
     154;
     125;
     85;
     68;
     38;
     23;
     10;
     24;
     83;
     133;
     131;
     118;
     90;
     67;
     60;
     47;
     41;
     21;
     16;
     6;
     4;
     7;
     14;
     34;
     45;
     43;
     49;
     42;
     28;
     10;
     5;
     2;
     0;
     1;
     3;
     12;
     14;
```

```
     35;
     47;
     41;
     30;
     24;
     16;
     7;
     4;
     2;
     8;
     13;
     36;
     50;
     62;
     67;
     72;
     48;
     29;
     8;
     13;
     57;
     122;
     139;
     103;
     86;
     63;
     37;
     26;
     11;
     15;
     40;
     62;
     98;
     124;
     96;
     65;
     64;
     54;
     39;
     21;
     7;
     4;
     23;
     53;
     94;
     96;
     77;
     59;
     44;
     47;
     30;
     16;
     7;
     37;
     74];
m = int32(8);
rs = 'RANGE';
[y, mean, ifail] = g13au(z, m, rs)
```

```
y =
   148
   123
    84
    45
    28
    40
    65
   131
    92
    85
```

```
    92
    67
mean =
   72.3750
   70.0000
   43.5000
   29.7500
    7.6250
   26.7500
   30.2500
   61.0000
   47.6250
   75.2500
   46.8750
   39.2500
ifail =
           0
```