NAG Toolbox for MATLAB

g13bd

1 Purpose

g13bd calculates preliminary estimates of the parameters of a transfer function model.

2 Syntax

```
[wds, isf, ifail] = g13bd(r0, r, nna, s, 'nl', nl)
```

3 Description

g13bd calculates estimates of parameters $\delta_1, \delta_2, \ldots, \delta_p$, $\omega_0, \omega_1, \ldots, \omega_q$ in the transfer function model

$$y_t = \delta_1 y_{t-1} + \delta_2 y_{t-2} + \cdots + \delta_p y_{t-p} + \omega_0 x_{t-b} - \omega_1 x_{t-b-1} - \cdots - \omega_q x_{t-b-q}$$

given cross-correlations between the series x_t and lagged values of y_t:

$$r_{xy}(l), \qquad l = 0, 1, \ldots, L$$

and the ratio of standard deviations s_y/s_x, as supplied by g13bc.

It is assumed that the series x_t used to calculate the cross-correlations is a sample from a time series with true autocorrelations of zero. Otherwise the cross-correlations between the series b_t and a_t, as defined in the description of g13ba, should be used in place of those between y_t and x_t.

The estimates are obtained by solving for $\delta_1, \delta_2, \ldots, \delta_p$ the equations

$$r_{xy}(b+q+j) = \delta_1 r_{xy}(b+q+j-1) + \cdots + \delta_p r_{xy}(b+q+j-p), \qquad j = 1, 2, \ldots, p$$

then calculating

$$\omega_i = \pm\left(s_y/s_x\right) r_{xy}(b+i) - \delta_1 r_{xy}(b+i-1) - \cdots - \delta_p r_{xy}(b+i-p), \qquad i = 0, 1, \ldots, q$$

where the '+' is used for ω_0 and '−' for ω_i, $i > 0$.

Any value of $r_{xy}(l)$ arising in these equations for $l < b$ is taken as zero. The parameters $\delta_1, \delta_2, \ldots, \delta_p$ are checked as to whether they satisfy the stability criterion.

4 References

Box G E P and Jenkins G M 1976 *Time Series Analysis: Forecasting and Control* (Revised Edition) Holden–Day

5 Parameters

5.1 Compulsory Input Parameters

1: **r0 – double scalar**

The cross-correlation between the two series at lag 0, $r_{xy}(0)$.

Constraint: $-1.0 \leq$ **r0** ≤ 1.0.

2: **r(nl) – double array**

The cross-correlations between the two series at lags 1 to L, $r_{xy}(l)$, for $l = 1, 2, \ldots, L$.

Constraint: $-1.0 \leq \mathbf{r}(i) \leq 1.0$, for $i = 1, 2, \ldots,$ **nl**.

3: **nna**(**3**) – **int32 array**

The transfer function model orders in the standard form b, q, p (i.e., delay time, number of moving-average MA-like followed by number of autoregressive AR-like parameters).

Constraint: if $i = 1, 2, 3$, $\mathbf{nna}(i) \geq 0$.

4: **s** – **double scalar**

The ratio of the standard deviation of the y series to that of the x series, s_y/s_x.

Constraint: $\mathbf{s} > 0.0$.

5.2 Optional Input Parameters

1: **nl** – **int32 scalar**

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

L, the number of lagged cross-correlations in the array **r**.

Constraint: $\mathbf{nl} \geq \max(\mathbf{nna}(1) + \mathbf{nna}(2) + \mathbf{nna}(3), 1)$.

5.3 Input Parameters Omitted from the MATLAB Interface

nwds, wa, iwa

5.4 Output Parameters

1: **wds**(**nwds**) – **double array**

The preliminary estimates of the parameters of the transfer function model in the order of $q + 1$ MA-like parameters followed by the p AR-like parameters. If the estimation of either type of parameter fails then these parameters are set to 0.0.

2: **isf**(**2**) – **int32 array**

Indicators of the success of the estimation of MA-like and AR-like parameters respectively. A value 0 indicates that there are no parameters of that type to be estimated. A value of 1 or -1 indicates that there are parameters of that type in the model and the estimation of that type has been successful or unsuccessful respectively. Note that there is always at least one MA-like parameter in the model.

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, $\mathbf{nna}(i) < 0$, for $i = 1, 2, 3$,
or $\mathbf{nl} < \max(\mathbf{nna}(1) + \mathbf{nna}(2) + \mathbf{nna}(3), 1)$,
or $\mathbf{r0} < -1.0$ or $\mathbf{r0} > 1.0$,
or $\mathbf{r}(i) < -1.0$ or $\mathbf{r}(i) > 1.0$, for some $i = 1, 2, \ldots, \mathbf{nl}$,
or $\mathbf{s} \leq 0.0$,
or $\mathbf{nwds} \neq \mathbf{nna}(2) + \mathbf{nna}(3) + 1$,
or $\mathbf{iwa} < \mathbf{nna}(3) \times (\mathbf{nna}(3) + 1)$.

ifail $= -999$

Internal memory allocation failed.

7 Accuracy

Equations used in the computations may become unstable, in which case results are reset to zero with array **isf** values set accordingly.

8 Further Comments

If **nna**$(3) > 0$, a local workspace array of fixed length is allocated internally by g13bd. The total size of this array amounts to **nna**(3) integer elements.

The time taken by g13bd is roughly proportional to **nwds**^{3}.

9 Example

```
r0 = -0.0155;
r = [0.0339;
     -0.0374;
     -0.2895;
     -0.343;
     -0.4518;
     -0.2787];
nna = [int32(3);
     int32(2);
     int32(1)];
s = 1.9256;
[wds, isf, ifail] = g13bd(r0, r, nna, s)
```

```
wds =
   -0.5575
    0.3166
    0.4626
    0.6169
isf =
           1
           1
ifail =
           0
```