

NAG Toolbox

nag_tsa_multi_transf_prelim (g13bd)

1 Purpose

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

2 Syntax

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

3 Description

nag_tsa_multi_transf_prelim (g13bd) calculates estimates of parameters $\delta_1, \delta_2, \dots, \delta_p, \omega_0, \omega_1, \dots, \omega_q$ in the transfer function model

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

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

$$r_{xy}(l), \quad l = 0, 1, \dots, L$$

and the ratio of standard deviations s_y/s_x , as supplied by nag_tsa_multi_xcorr (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 nag_tsa_multi_filter_arima (g13ba), should be used in place of those between y_t and x_t .

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

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

then calculating

$$\omega_i = \pm (s_y/s_x) [r_{xy}(b+i) - \delta_1 r_{xy}(b+i-1) - \dots - \delta_p r_{xy}(b+i-p)], \quad i = 0, 1, \dots, q$$

where the '+' is used for ω_0 and '-' for $\omega_i, i > 0$.

Any value of $r_{xy}(l)$ arising in these equations for $l < b$ is taken as zero. The parameters $\delta_1, \delta_2, \dots, \delta_p$ 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** – REAL (KIND=nag_wp)

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

Constraint: $-1.0 \leq \mathbf{r0} \leq 1.0$.

- 2: **r(nl)** – REAL (KIND=nag_wp) array
 The cross-correlations between the two series at lags 1 to L , $r_{xy}(l)$, for $l = 1, 2, \dots, L$.
Constraint: $-1.0 \leq \mathbf{r}(i) \leq 1.0$, for $i = 1, 2, \dots, \mathbf{nl}$.
- 3: **nna(3)** – INTEGER 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: $\mathbf{nna}(i) \geq 0$, for $i = 1, 2, 3$.
- 4: **s** – REAL (KIND=nag_wp)
 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** – INTEGER
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 Output Parameters

- 1: **wds(nwds)** – REAL (KIND=nag_wp) array
 $nwds = \mathbf{nna}(2) + \mathbf{nna}(3) + 1$.
 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 arguments are set to 0.0.
- 2: **isf(2)** – INTEGER 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** – INTEGER
ifail = 0 unless the function detects an error (see Section 5).

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 $i = 1, 2, \dots, \mathbf{nl}$,
- or $\mathbf{s} \leq 0.0$,
- or $nwds \neq \mathbf{nna}(2) + \mathbf{nna}(3) + 1$,
- or $iwa < \mathbf{nna}(3) \times (\mathbf{nna}(3) + 1)$.

ifail = -99

An unexpected error has been triggered by this routine. Please contact NAG.

ifail = -399

Your licence key may have expired or may not have been installed correctly.

ifail = -999

Dynamic 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 `nag_tsa_multi_transf_prelim` (g13bd). The total size of this array amounts to **nna**(3) integer elements and **nna**(3) × (**nna**(3) + 1) double elements.

The time taken by `nag_tsa_multi_transf_prelim` (g13bd) is roughly proportional to $nwds^3$.

9 Example

This example reads the cross-correlations between two series at lags 0 to 6. It then reads a (3,2,1) transfer function model and calculates and prints the preliminary estimates of the parameters of the model.

9.1 Program Text

```
function g13bd_example

fprintf('g13bd example results\n\n');

% Cross-correlation at lag 0
r0 = -0.0155;
% Other cross-correlations
r = [0.0339; -0.0374; -0.2895; -0.3430; -0.4518; -0.2787];

% transfer function model orders
nna = [nag_int(3);2;1];

%Standard deviation ratio
s = 1.9256;

% Calculate parameter estimates
[wds, isf, ifail] = g13bd( ...
                    r0, r, nna, s);

% Display results
fprintf('Success/failure indicator      = %4d%4d\n\n', isf(1:2));
fprintf('Transfer function model B, Q, P = %4d%4d%4d\n\n', nna(1:3));
disp('Parameter initial estimates');
disp(wds');
```

9.2 Program Results

g13bd example results

Success/failure indicator = 1 1

Transfer function model B, Q, P = 3 2 1

Parameter initial estimates

-0.5575 0.3166 0.4626 0.6169
