NAG Toolbox for MATLAB

g13bg

1 Purpose

g13bg accepts a series of new observations of an output time series and any associated input time series, for which a multi-input model is already fully specified, and updates the 'state set' information for use in constructing further forecasts.

The previous specification of the multi-input model will normally have been obtained by using g13be to estimate the relevant transfer function and ARIMA parameters. The supplied state set will originally have been produced by g13be (or possibly g13bj), but may since have been updated by g13bg.

2 Syntax

```
[sttf, xxyn, res, ifail] = g13bg(sttf, mr, mt, para, nnv, xxyn, kzef,
'nsttf', nsttf, 'nser', nser, 'npara', npara)
```

3 Description

The multi-input model is specified in Section 3 of the document for g13be. The form of these equations required to update the state set is as follows:

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

the transfer models which generate input component values $z_{i,t}$ from one or more inputs $x_{i,t}$,

$$n_t = y_t - z_{1,t} - z_{2,t} - \cdots - z_{m,t}$$

which generates the output noise component from the output y_t and the input components, and

$$\begin{aligned} w_t &= \nabla^d \nabla_s^D n_t - c \\ e_t &= w_t - \Phi_1 w_{t-s} - \Phi_2 w_{t-2\times s} - \cdots - \Phi_P w_{t-P\times s} + \Theta_1 e_{t-s} + \Theta_2 e_{t-2\times s} + \cdots + \Theta_Q e_{t-Q\times s} \\ a_t &= e_t - \phi_1 e_{t-1} - \phi_2 e_{t-2} - \cdots - \phi_p e_{t-p} + \theta_1 a_{t-1} + \theta_2 a_{t-2} + \cdots + \theta_q a_{t-q} \end{aligned}$$

the ARIMA model for the output noise which generates the residuals a_t.

The state set (as also given in Section 3 of the document for g13be) is the collection of terms

$$z_{n+1-k}, x_{n+1-k}, n_{n+1-k}, w_{n+1-k}, e_{n+1-k} \qquad \text{and} \qquad a_{n+1-k}$$

for $k = 1$ up to the maximum lag associated with each of these series respectively, in the above model equations. n is the latest time point of the series from which the state set has been generated.

The function accepts further values of the series y_t, $x_{1,t}, x_{2,t}, \ldots, x_{m,t}$, for $t = n+1, n+2, \ldots, n+l$, and applies the above model equations over this time range, to generate new values of the various model components, noise series and residuals. The state set is reconstructed, corresponding to the latest time point $n+l$, the earlier values being discarded.

The set of residuals corresponding to the new observations may be of use in checking that the new observations conform to the previously fitted model. The components of the new observations of the output series which are due to the various inputs, and the noise component, are also optionally returned.

The parameters of the model are not changed in this function.

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: **sttf**(**nsttf**) – **double array**

The **nsttf** values in the state set before updating as returned by g13be, g13bj or a previous call to g13bg.

2: **mr**(**7**) – **int32 array**

The orders vector (p, d, q, P, D, Q, s) of the ARIMA model for the output noise component.

p, q, P and Q refer respectively to the number of autoregressive (ϕ), moving average (θ), seasonal autoregressive (Φ) and seasonal moving average (Θ) parameters.

d, D and s refer respectively to the order of non-seasonal differencing, the order of seasonal differencing, and the seasonal period.

Constraints:

p, d, q, P, D, Q, $s \geq 0$;
$p + q + P + Q > 0$;
$s \neq 1$;
if $s = 0$, $P + D + Q = 0$;
if $s > 1$, $P + D + Q > 0$.

3: **mt**(**4,nser**) – **int32 array**

The transfer function model orders b, p and q of each of the input series. The data for input series i are held in column i. Row 1 holds the value b_i, row 2 holds the value q_i and row 3 holds the value p_i. For a simple input, $b_i = q_i = p_i = 0$.

Row 4 holds the value r_i, where $r_i = 1$ for a simple input and $r_i = 2$ or 3 for a transfer function input. When $r_i = 1$ any nonzero contents of rows 1, 2 and 3 of column i are ignored. The choice of $r_i = 2$ or $r_i = 3$ is an option for use in model estimation and does not affect the operation of g13bg.

Constraint: $\mathbf{mt}(4, i) = 1,\ 2 \text{ or } 3$, for $i = 1, 2, \ldots, \mathbf{nser} - 1$.

4: **para**(**npara**) – **double array**

Estimates of the multi-input model parameters as returned by g13be. These are in order, firstly the ARIMA model parameters: p values of ϕ parameters, q values of θ parameters, P values of Φ parameters and Q values of Θ parameters. These are followed by the transfer function model parameter values $\omega_0, \omega_1, \ldots, \omega_{q_1}$, $\delta_1, \delta_2, \ldots, \delta_{p_1}$ for the first of any input series and similarly for each subsequent input series. The final component of **para** is the value of the constant c.

5: **nnv** – **int32 scalar**

the number of new observation sets being used to update the state set, each observation set consisting of a value of the output series and the associated values of each of the input series at a particular time point.

6: **xxyn**(**ldxxyn,nser**) – **double array**

ldxxyn, the first dimension of the array, must be at least **nnv**.

The **nnv** new observation sets being used to update the state set. Column i contains the values of input series i, for $i = 1, 2, \ldots, \mathbf{nser} - 1$. Column **nser** contains the values of the output series. Consecutive rows correspond to increasing time sequence.

7: **kzef – int32 scalar**

Must not be set to 0, if the values of the input component series z_t and the values of the output noise component n_t are to overwrite the contents of **xxyn** on exit, and must be set to 0 if **xxyn** is to remain unchanged on exit.

5.2 Optional Input Parameters

1: **nsttf – int32 scalar**

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

the exact number of values in the state set array **sttf** as returned by g13be or g13bj.

2: **nser – int32 scalar**

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

the total number of input and output series. There may be any number of input series (including none), but only one output series.

3: **npara – int32 scalar**

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

the exact number of ϕ, θ, Φ, Θ, ω, δ and c parameters. (c must be included whether its value was previously estimated or was set fixed.)

5.3 Input Parameters Omitted from the MATLAB Interface

ldxxyn, wa, iwa

5.4 Output Parameters

1: **sttf**(**nsttf**) **– double array**

The state set values after updating.

2: **xxyn**(**ldxxyn,nser**) **– double array**

If **kzef** $= 0$, **xxyn** remains unchanged.

If **kzef** $\neq 0$, the columns of **xxyn** hold the corresponding values of the input component series z_t and the output noise component n_t in that order.

3: **res**(**nnv**) **– double array**

The values of the residual series a_t corresponding to the new observations of the output series.

4: **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, **nsttf** is not consistent with the orders in arrays **mr** and **mt**.

ifail $= 2$

On entry, **npara** is not consistent with the orders in arrays **mr** and **mt**.

ifail $= 3$

On entry, **ldxxyn** is too small.

ifail $= 4$

On entry, **iwa** is too small.

ifail $= 5$

On entry, one of the r_i, stored in $\mathbf{mt}(4,i)$, for $i = 1,2,\ldots,\mathbf{nser}-1$ does not equal 1, 2 or 3.

7 Accuracy

The computations are believed to be stable.

8 Further Comments

The time taken by g13bg is approximately proportional to $\mathbf{nnv} \times \mathbf{npara}$.

9 Example

```
sttf = [6.053;
     184.4749;
     -80.0885;
     -75.1704;
     -76.9481;
     -81.47490000000001;
     0.7776;
     -2.619;
     -2.3054;
     -1.1963];
mr = [int32(1);
     int32(0);
     int32(0);
     int32(0);
     int32(1);
     int32(1);
     int32(4)];
mt = [int32(1), int32(0);
     int32(0), int32(0);
     int32(1), int32(0);
     int32(3), int32(0)];
para = [0.5158;
     0.9994;
     8.6343;
     0.6726;
     -0.3172];
nnv = int32(4);
xxyn = [5.941, 96;
     5.386, 95;
     5.811, 80;
     6.716, 88];
kzef = int32(1);
[sttfOut, xxynOut, res, ifail] = g13bg(sttf, mr, mt, para, nnv, xxyn,
kzef)
```

```
sttfOut =
    6.7160
  158.3155
  -80.3412
  -74.9035
  -80.7814
  -70.3155
```

```
    0.8416
   -2.0333
   -5.8201
   10.2810
xxynOut =
  176.3412  -80.3412
  169.9035  -74.9035
  160.7814  -80.7814
  158.3155  -70.3155
res =
    1.4586
   -2.4674
   -4.7714
   13.2830
ifail =
           0
```