NAG Toolbox for MATLAB

g13ah

1 Purpose

g13ah produces forecasts of a time series, given a time series model which has already been fitted to the time series using g13ae or g13af. The original observations are not required, since g13ah uses as input either the original state set produced by g13ae or g13af or the state set updated by a series of new observations using g13ag. Standard errors of the forecasts are also provided.

2 Syntax

```
[fva, fsd, ifail] = g13ah(st, mr, par, c, rms, nfv, 'nst', nst, 'npar',
npar)
```

3 Description

The original time series is x_t, for $t = 1, 2, \ldots, n$ and parameters have been fitted to the model of this time series using g13ae or g13af.

Forecasts of x_t, for $t = n + 1, n + 2, \ldots, n + L$, are calculated in five stages, as follows:

(i) set $a_t = 0$ for $t = N + 1, N + 2, \ldots, N + L$, where $N = n - d - (D \times s)$ is the number of differenced values in the series;

(ii) calculate the values of e_t, for $t = N + 1, N + 2, \ldots, N + L$, and $e_t = \phi_1 \times e_{t-1} + \cdots + \phi_p \times e_{t-p} + a_t - \theta_1 \times a_{t-1} - \cdots - \theta_q \times a_{t-q}$;

(iii) calculate the values of w_t, for $t = N + 1, N + 2, \ldots, N + L$, where $w_t = \Phi_1 \times w_{t-s} + \cdots + \Phi_P \times w_{t-s\times P} + e_t - \Theta_1 \times e_{t-s} - \cdots - \Theta_Q \times e_{t-s\times Q}$ and w_t for $t \leq N$ are the first $s \times P$ values in the state set, corrected for the constant;

(iv) add the constant term c to give the differenced series $\nabla^d \nabla_s^D x_t = w_t + c$, for $t = N + 1, N + 2, \ldots, N + L$;

(v) the differencing operations are reversed to reconstitute x_t, for $t = n + 1, n + 2, \ldots n + L$.

The standard errors of these forecasts are given by $s_t = V \times \left(\psi_0^2 + \psi_1^2 + \ldots + \psi_{t-n-1}^2\right)^{1/2}$, for $t = n + 1, n + 2, \ldots, n + L$, where $\psi_0 = 1$, V is the residual variance of a_t, and ψ_j is the coefficient expressing the dependence of x_t on a_{t-j}.

To calculate ψ_j for $j = 1, 2, \ldots, (L - 1)$ the following device is used.

A copy of the state set is initialized to zero throughout and the calculations outlined above for the construction of forecasts are carried out with the settings $a_{N+1} = 1$, and $a_t = 0$, for $t = N + 2, N + 3, \ldots, N + L$.

The resulting quantities corresponding to the sequence $x_{N+1}, x_{N+2}, \ldots, x_{N+L}$ are precisely 1, $\psi_1, \psi_2, \ldots, \psi_{L-1}$.

The supplied time series model is used throughout these calculations, with the exception that the constant term c is taken to be zero.

4 References

None.

5 Parameters

5.1 Compulsory Input Parameters

1: **st(nst) – double array**

The state set derived from g13ae or g13af originally, or as modified using earlier calls of g13ag.

2: **mr(7) – int32 array**

The orders vector (p, d, q, P, D, Q, s) of the ARIMA model, in the usual notation.

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: **par(npar) – double array**

The estimates of the p values of the ϕ parameters, the q values of the θ parameters, the P values of the Φ parameters and the Q values of the Θ parameters which specify the model and which were output originally by g13ae or g13af.

4: **c – double scalar**

c, the value of the model constant. This will have been output by g13ae or g13af.

5: **rms – double scalar**

V, the residual variance associated with the model.

If g13af was used to estimate the model, **rms** should be set to **s**/**ndf**, where **s** and **ndf** were output by g13af.

If g13ae was used to estimate the model, **rms** should be set to **s**/**icount**(5), where **s** and **icount**(5) were output by g13ae.

Constraint: **rms** ≥ 0.0.

6: **nfv – int32 scalar**

L, the required number of forecasts.

Constraint: **nfv** > 0.

5.2 Optional Input Parameters

1: **nst – int32 scalar**

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

the number of values in the state set array **st**.

Constraint: **nst** $= P \times s + D \times s + d + q + \max(p, Q \times s)$. (As returned by g13ae or g13af).

2: **npar – int32 scalar**

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

The number of ϕ, θ, Φ and Θ parameters in the model.

Constraint: **npar** $= p + q + P + Q$.

5.3 Input Parameters Omitted from the MATLAB Interface

wa, nwa

5.4 Output Parameters

1: **fva(nfv) – double array**

nfv forecast values relating to the original undifferenced series.

2: **fsd(nfv) – double array**

The standard errors associated with each of the **nfv** forecast values in **fva**.

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, **npar** $\neq p + q + P + Q$,
or the orders vector **mr** is invalid (check the constraints given in Section 5).

ifail $= 2$

On entry, **nst** $\neq P \times s + D \times s + d + q + \max(Q \times s, p)$.

ifail $= 3$

On entry, **nfv** ≤ 0.

ifail $= 4$

On entry, **nwa** $< 4 \times$ **npar** $+ 3 \times$ **nst**.

ifail $= 5$

On entry, **rms** < 0.0.

7 Accuracy

The computations are believed to be stable.

8 Further Comments

The time taken by g13ah is approximately proportional to **nfv** $\times$ **npar**.

9 Example

```
st = [0.066;
     -0.0513;
     0.1715;
     -0.0249;
     0.0588;
     0.1167;
     0.1493;
     0.0199;
```

```
     -0.1884;
     -0.1289;
     -0.1172;
     0.1122;
     6.0039;
     0.0443;
     -0.007;
     0.0252;
     0.002;
     0.0353;
     -0.046;
     0.0374;
     0.0151;
     -0.0237;
     0.0031;
     0.0188;
     0.0066;
     0.0125];
mr = [int32(0);
     int32(1);
     int32(1);
     int32(0);
     int32(1);
     int32(1);
     int32(12)];
par = [0.327;
     0.6262];
c = 0;
rms = 0.0014;
nfv = int32(12);
[fva, fsd, ifail] = g13ah(st, mr, par, c, rms, nfv)
```

```
fva =
    6.0381
    5.9912
    6.1469
    6.1207
    6.1574
    6.3029
    6.4288
    6.4392
    6.2657
    6.1348
    6.0059
    6.1139
fsd =
    0.0374
    0.0451
    0.0517
    0.0575
    0.0627
    0.0676
    0.0721
    0.0764
    0.0805
    0.0843
    0.0880
    0.0915
ifail =
           0
```