NAG Toolbox

nag_smooth_data_runningmedian (g10ca)

1 Purpose

nag_smooth_data_runningmedian (g10ca) computes a smoothed data sequence using running median smoothers.

2 Syntax

```
[smooth, rough, ifail] = nag_smooth_data_runningmedian(itype, y, 'n', n)
[smooth, rough, ifail] = g10ca(itype, y, 'n', n)
```

3 Description

Given a sequence of n observations recorded at equally spaced intervals, nag_smooth_data_runningmedian (g10ca) fits a smooth curve through the data using one of two smoothers. The two smoothers are based on the use of running medians and averages to summarise overlapping segments. The fit and the residuals are called the smooth and the rough respectively. They obey the following:

$$\text{Data} = \text{Smooth} + \text{Rough}.$$

The two smoothers are:

1. 4253H,twice consisting of a running median of 4, then 2, then 5, then 3 followed by hanning. Hanning is a running weighted average, the weights being $1/4$, $1/2$ and $1/4$. The result of this smoothing is then reroughed by computing residuals, applying the same smoother to them and adding the result to the smooth of the first pass.
2. 3RSSH,twice consisting of a running median of 3, two splitting operations named S to improve the smooth sequence, each of which is followed by a running median of 3, and finally hanning. The end points are dealt with using the method described by Velleman and Hoaglin (1981). The full smoother 3RSSH,twice is produced by reroughing as described above.

The compound smoother 4253H,twice is recommended. The smoother 3RSSH,twice is popular when calculating by hand as it requires simpler computations and is included for comparison purposes.

4 References

Tukey J W (1977) *Exploratory Data Analysis* Addison–Wesley

Velleman P F and Hoaglin D C (1981) *Applications, Basics, and Computing of Exploratory Data Analysis* Duxbury Press, Boston, MA

5 Parameters

5.1 Compulsory Input Parameters

1: **itype** – INTEGER

Specifies the method to be used.

If **itype** $= 0$, 4253H,twice is used.

If **itype** $= 1$, 3RSSH,twice is used.

Constraint: **itype** $= 0$ or 1.

2: **y**(**n**) – REAL (KIND=nag_wp) array

The sample observations.

5.2 Optional Input Parameters

1: **n** – INTEGER

Default: the dimension of the array **y**.

n, the number of observations.

Constraint: **n** > 6.

5.3 Output Parameters

1: **smooth**(**n**) – REAL (KIND=nag_wp) array

Contains the smooth.

2: **rough**(**n**) – REAL (KIND=nag_wp) array

Contains the rough.

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, **itype** < 0,
or **itype** > 1.

ifail $= 2$

On entry, **n** ≤ 6.

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

Not applicable.

8 Further Comments

Alternative methods of smoothing include the use of splines; see nag_smooth_fit_spline (g10ab) and nag_smooth_fit_spline_parest (g10ac).

9 Example

This example reads in a sequence of 49 observations on bituminous coal production (in millions of net tons per year) in the USA., 1920–1968 and is taken from Tukey (1977). For comparison purposes, both smoothers are applied to the data and the results are printed.

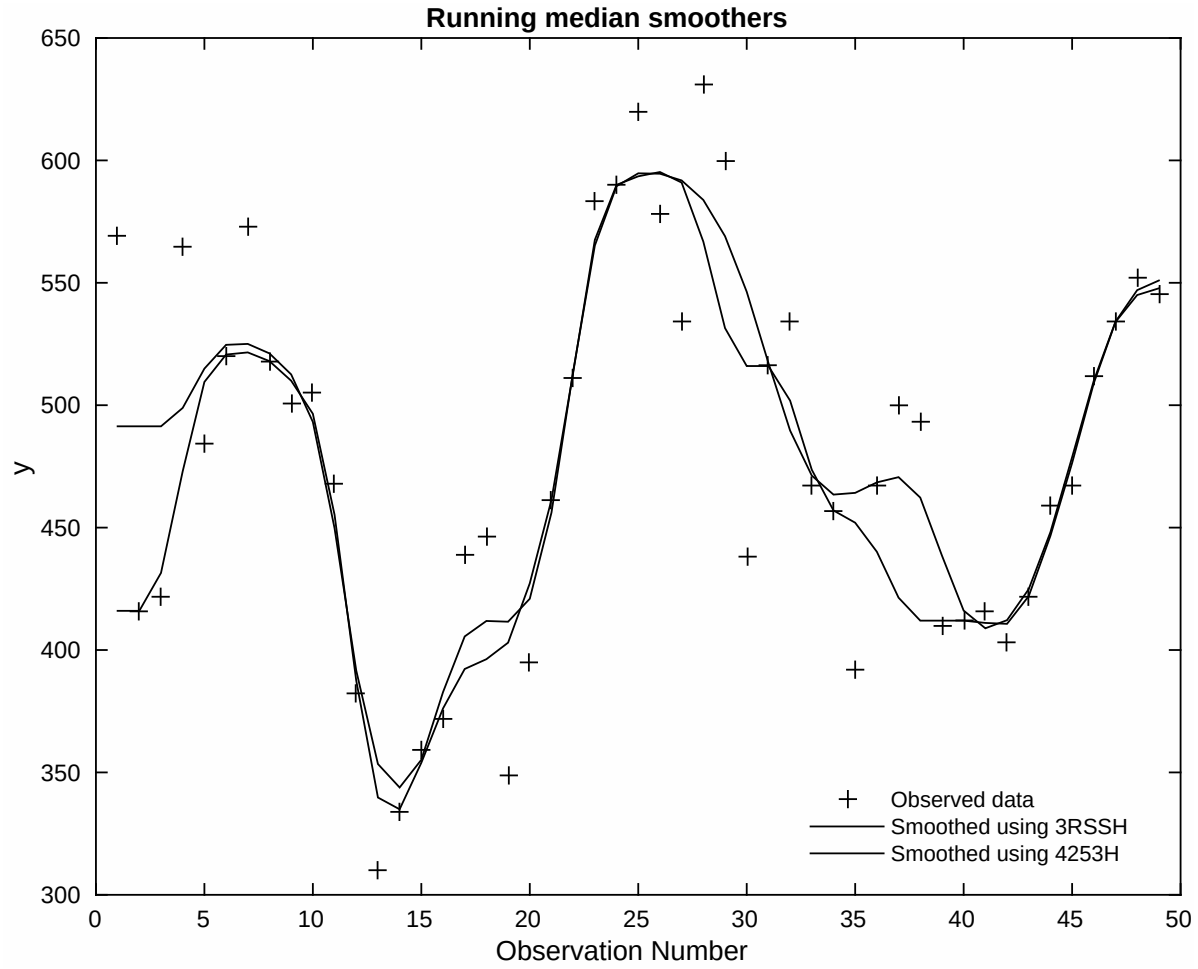
9.1 Program Text

```
     function g10ca_example

fprintf('g10ca example results\n\n');

y = [569; 416; 422; 565; 484; 520; 573; 518; 501; 505;
     468; 382; 310; 334; 359; 372; 439; 446; 349; 395;
     461; 511; 583; 590; 620; 578; 534; 631; 600; 438;
     516; 534; 467; 457; 392; 467; 500; 493; 410; 412;
     416; 403; 422; 459; 467; 512; 534; 552; 545];

% Smooth sequence using 3RSSH,twice
itype = nag_int(1);
[smooth1, rough1, ifail] = g10ca( ...
                                  itype, y);

% Smooth sequence using 4253H,twice
itype = nag_int(0);
[smooth0, rough0, ifail] = g10ca( ...
                                  itype, y);

% Display results
fprintf('%39s%26s\n', 'Using 3RSSH,twice', 'Using 4253H,twice');
fprintf('%6s%9s%13s%13s%13s%13s\n', ' Index', '     Data', '      Smooth', ...
        '        Rough', '       Smooth', '       Rough');
ivar = [1:numel(y)]';
results = [ivar y smooth1 rough1 smooth0 rough0];
fprintf('%4d%11.1f%13.1f%13.1f%13.1f%13.1f\n', results');

fig1 = figure;
plot(ivar,y,'+',ivar,smooth1,ivar,smooth0);
legend('Observed data', 'Smoothed using 3RSSH', 'Smoothed using 4253H', ...
       'Location', 'SouthEast');
legend('boxoff');
xlabel('Observation Number');
ylabel('y');
title('Running median smoothers');
```

9.2 Program Results

```
     g10ca example results

                      Using 3RSSH,twice         Using 4253H,twice
 Index     Data       Smooth        Rough       Smooth        Rough
   1      569.0        416.0        153.0        491.4         77.6
   2      416.0        416.0          0.0        491.4        -75.4
   3      422.0        431.5         -9.5        491.4        -69.4
   4      565.0        473.0         92.0        498.9         66.1
   5      484.0        509.5        -25.5        514.9        -30.9
   6      520.0        520.7         -0.7        524.7         -4.7
   7      573.0        521.6         51.4        525.0         48.0
   8      518.0        518.0          0.0        521.2         -3.2
   9      501.0        510.0         -9.0        512.6        -11.6
  10      505.0        496.5          8.5        493.2         11.8
  11      468.0        455.2         12.8        449.7         18.3
  12      382.0        387.5         -5.5        391.6         -9.6
  13      310.0        339.8        -29.8        353.4        -43.4
  14      334.0        334.9         -0.9        343.8         -9.8
  15      359.0        353.9          5.1        355.2          3.8
  16      372.0        376.1         -4.1        382.8        -10.8
  17      439.0        392.2         46.8        405.5         33.5
  18      446.0        396.2         49.8        411.9         34.1
```

19	349.0	403.0	-54.0	411.6	-62.6
20	395.0	427.2	-32.2	420.9	-25.9
21	461.0	461.4	-0.4	456.1	4.9
22	511.0	513.3	-2.3	513.9	-2.9
23	583.0	567.6	15.4	565.2	17.8
24	590.0	590.0	0.0	589.5	0.5
25	620.0	593.5	26.5	594.7	25.3
26	578.0	595.2	-17.2	594.6	-16.6
27	534.0	590.9	-56.9	591.8	-57.8
28	631.0	566.8	64.2	583.8	47.2
29	600.0	531.5	68.5	569.0	31.0
30	438.0	516.0	-78.0	546.3	-108.3
31	516.0	516.0	0.0	517.3	-1.3
32	534.0	501.9	32.1	489.6	44.4
33	467.0	473.6	-6.6	471.2	-4.2
34	457.0	457.0	0.0	463.5	-6.5
35	392.0	452.0	-60.0	464.2	-72.2
36	467.0	440.1	26.9	468.5	-1.5
37	500.0	421.4	78.6	470.6	29.4
38	493.0	412.0	81.0	462.3	30.7
39	410.0	412.0	-2.0	438.6	-28.6
40	412.0	412.0	0.0	416.1	-4.1
41	416.0	411.1	4.9	408.9	7.1
42	403.0	410.7	-7.7	412.2	-9.2
43	422.0	422.0	0.0	424.9	-2.9
44	459.0	446.6	12.4	448.1	10.9
45	467.0	476.4	-9.4	478.8	-11.8
46	512.0	509.0	3.0	510.0	2.0
47	534.0	534.0	0.0	534.1	-0.1
48	552.0	545.0	7.0	547.0	5.0
49	545.0	547.8	-2.8	550.9	-5.9


Running median smoothers
650
600
550
500
450
400
350
300
y
0
5
10
15
20
25
30
35
40
45
50
Observation Number
Observed data
Smoothed using 3RSSH
Smoothed using 4253H