

NAG C Library Function Document

nag_tsa_mean_range (g13auc)

1 Purpose

nag_tsa_mean_range (g13auc) calculates the range (or standard deviation) and the mean for groups of successive time series values. It is intended for use in the construction of range-mean plots.

2 Specification

```
void nag_tsa_mean_range (Integer n, const double z[], Integer m, Nag_RangeStat rs,
    double y[], double mean[], NagError *fail)
```

3 Description

Let Z_1, Z_2, \dots, Z_n denote n successive observations in a time series. The series may be divided into groups of m successive values and for each group the range or standard deviation (depending on a user-supplied option) and the mean are calculated. If n is not a multiple of m then groups of equal size m are found starting from the end of the series of observations provided, and any remaining observations at the start of the series are ignored. The number of groups used, k , is the integer part of n/m . If the user wishes to ensure that no observations are ignored then the number of observations, n , should be chosen so that n is divisible by m .

The mean, M_i , the range, R_i , and the standard deviation, S_i , for the i th group are defined as

$$M_i = \frac{1}{m} \sum_{j=1}^m Z_{l+m(i-1)+j}$$

$$R_i = \max_{1 \leq j \leq m} \{Z_{l+m(i-1)+j}\} - \min_{1 \leq j \leq m} \{Z_{l+m(i-1)+j}\}$$

and

$$S_i = \sqrt{\left(\frac{1}{m-1}\right) \sum_{j=1}^m (Z_{l+m(i-1)+j} - M_i)^2}$$

where $l = n - km$, the number of observations ignored.

For seasonal data it is recommended that m should be equal to the seasonal period. For nonseasonal data the recommended group size is 8.

A plot of range against mean or of standard deviation against mean is useful for finding a transformation of the series which makes the variance constant. If the plot appears random or the range (or standard deviation) seems to be constant irrespective of the mean level then this suggests that no transformation of the time series is called for. On the other hand an approximate linear relationship between range (or standard deviation) and mean would indicate that a log transformation is appropriate. Further details may be found in either Jenkins (1979) or McLeod (1982).

The user has the choice of whether to use the range or the standard deviation as a measure of variability. If the group size is small they are both equally good but if the group size is fairly large (e.g., $m = 12$ for monthly data) then the range may not be as good an estimate of variability as the standard deviation.

4 References

Jenkins G M (1979) *Practical Experiences with Modelling and Forecasting Time Series* GJP Publications, Lancaster

McLeod G (1982) *Box-Jenkins in Practice. 1: Univariate Stochastic and Single Output Transfer Function/ Noise Analysis* GJP Publications, Lancaster

5 Parameters

- 1: **n** – Integer *Input*
 On entry: the number of observations in the time series, n .
 Constraint: $n \geq m$.

- 2: **z[n]** – const double *Input*
 On entry: **z[t]** must contain the t th observation Z_t , for $t = 1, 2, \dots, n$.

- 3: **m** – Integer *Input*
 On entry: the group size, m .
 Constraint: $m \geq 2$.

- 4: **rs** – Nag_RangeStat *Input*
 On entry: indicates whether ranges or standard deviations are to be calculated.
 If **rs** = **Nag_UseRange**, then ranges are calculated.
 If **rs** = **Nag_UseSD**, then standard deviations are calculated.
 Constraint: **rs** = **Nag_UseRange** or **Nag_UseSD**.

- 5: **y[dim]** – double *Output*
 Note: the dimension, dim , of the array **y** must be at least (n/m) .
 On exit: **y[i - 1]** contains the range or standard deviation, as determined by **rs**, of the i th group of observations, for $i = 1, 2, \dots, k$.

- 6: **mean[dim]** – double *Output*
 Note: the dimension, dim , of the array **mean** must be at least (n/m) .
 On exit: **mean[i - 1]** contains the mean of the i th group of observations, for $i = 1, 2, \dots, k$.

- 7: **fail** – NagError * *Input/Output*
 The NAG error parameter (see the Essential Introduction).

6 Error Indicators and Warnings

NE_INT

On entry, **m** = $\langle value \rangle$.
 Constraint: $m \geq 2$.

NE_INT_2

On entry, **n** = $\langle value \rangle$, **m** = $\langle value \rangle$.
 Constraint: $n \geq m$.

NE_BAD_PARAM

On entry, parameter $\langle value \rangle$ had an illegal value.

NE_INTERNAL_ERROR

An internal error has occurred in this function. Check the function call and any array sizes. If the call is correct then please consult NAG for assistance.

7 Accuracy

The computations are believed to be stable.

8 Further Comments

The time taken by the routine is approximately proportional to n .

9 Example

The following program produces the statistics for a range-mean plot for a series of 100 observations divided into groups of 8.

9.1 Program Text

```
/* nag_tsa_mean_range (g13auc) Example Program.
 *
 * Copyright 2002 Numerical Algorithms Group.
 *
 * Mark 7, 2002.
 */

#include <stdio.h>
#include <nag.h>
#include <nag_stdlib.h>
#include <nagg13.h>

int main(void)
{
    /* Scalars */
    Integer exit_status, i, ngrps, m, n;

    /* Arrays */
    double *mean = 0, *range = 0, *z = 0;
    NagError fail;

    INIT_FAIL(fail);
    exit_status = 0;

    Vprintf("g13auc Example Program Results\n");

    /* Skip heading in data file */
    Vscanf("%*[\n] ");

    Vscanf("%ld%ld%*[\n] ", &n, &m);
    if (n >= m && m >= 1)
    {
        ngrps = n / m;

        /* Allocate arrays */
        if ( !(mean = NAG_ALLOC(ngrps, double)) ||
            !(range = NAG_ALLOC(ngrps, double)) ||
            !(z = NAG_ALLOC(n, double)) )
        {
            Vprintf("Allocation failure\n");
            exit_status = -1;
            goto END;
        }

        for (i = 1; i <= n; ++i)
            Vscanf("%lf", &z[i-1]);
        Vscanf("%*[\n] ");

        Vprintf("\n");

        g13auc(n, z, m, Nag_UseRange, range, mean, &fail);
        if (fail.code != NE_NOERROR)
```

```

    {
        Vprintf("Error from g13auc.\n%s\n", fail.message);
        exit_status = 1;
        goto END;
    }

    Vprintf("    Range        Mean\n");
    for (i = 1; i <= ngrps; i++)
        Vprintf("%8.3f  %8.3f\n", range[i-1], mean[i-1]);
}

END:
    if (mean) NAG_FREE(mean);
    if (range) NAG_FREE(range);
    if (z) NAG_FREE(z);

    return exit_status;
}

```

9.2 Program Data

g13auc Example Program Data

100 8 : n, no. of obs in time series, m, no. of obs in each group

101	82	66	35	31	6	20	90	154	125
85	68	38	23	10	24	83	133	131	118
90	67	60	47	41	21	16	6	4	7
14	34	45	43	49	42	28	10	5	2
0	1	3	12	14	35	47	41	30	24
16	7	4	2	8	13	36	50	62	67
72	48	29	8	13	57	122	139	103	86
63	37	26	11	15	40	62	98	124	96
65	64	54	39	21	7	4	23	53	94
96	77	59	44	47	30	16	7	37	74

: End of time series

9.3 Program Results

g13auc Example Program Results

Range	Mean
148.000	72.375
123.000	70.000
84.000	43.500
45.000	29.750
28.000	7.625
40.000	26.750
65.000	30.250
131.000	61.000
92.000	47.625
85.000	75.250
92.000	46.875
67.000	39.250
