

NAG Library Routine Document

G01ABF

Note: before using this routine, please read the Users' Note for your implementation to check the interpretation of *bold italicised* terms and other implementation-dependent details.

1 Purpose

G01ABF computes the means, standard deviations, corrected sums of squares and products, maximum and minimum values, and the product-moment correlation coefficient for two variables. Unequal weighting may be given.

2 Specification

```
SUBROUTINE G01ABF (N, X1, X2, IWT, WT, RES, IFAIL)
  INTEGER          N, IWT, IFAIL
  REAL (KIND=nag_wp) X1(N), X2(N), WT(N), RES(13)
```

3 Description

The data consist of two samples of n observations, denoted by x_i , and y_i , for $i = 1, 2, \dots, n$, with corresponding weights w_i , for $i = 1, 2, \dots, n$.

If no specific weighting is given, then each w_i is set to 1.0 in G01ABF.

The quantities calculated are:

- (a) The sum of weights,

$$W = \sum_{i=1}^n w_i.$$

- (b) The means,

$$\bar{x} = \frac{\sum_{i=1}^n w_i x_i}{W}, \quad \bar{y} = \frac{\sum_{i=1}^n w_i y_i}{W}.$$

- (c) The corrected sums of squares and products

$$c_{11} = \sum_{i=1}^n w_i (x_i - \bar{x})^2$$

$$c_{21} = c_{12} = \sum_{i=1}^n w_i (x_i - \bar{x})(y_i - \bar{y})$$

$$c_{22} = \sum_{i=1}^n w_i (y_i - \bar{y})^2.$$

- (d) The standard deviations

$$s_j = \sqrt{\frac{c_{jj}}{d}}, \quad \text{where } j = 1, 2 \quad \text{and} \quad d = W - \frac{\sum_{i=1}^n w_i^2}{W}.$$

(e) The product-moment correlation coefficient

$$R = \frac{c_{12}}{\sqrt{c_{11}c_{22}}}.$$

(f) The minimum and maximum elements in each of the two samples.

(g) The number of pairs of observations, m , for which $w_i > 0$, i.e., the number of **valid** observations. The quantities in (d) and (e) above will only be computed if $m \geq 2$. All other items are computed if $m \geq 1$.

4 References

None.

5 Arguments

- 1: N – INTEGER *Input*
On entry: n , the number of pairs of observations.
Constraint: $N \geq 1$.
- 2: X1(N) – REAL (KIND=nag_wp) array *Input*
On entry: the observations from the first sample, x_i , for $i = 1, 2, \dots, n$.
- 3: X2(N) – REAL (KIND=nag_wp) array *Input*
On entry: the observations from the second sample, y_i , for $i = 1, 2, \dots, n$.
- 4: IWT – INTEGER *Input/Output*
On entry: indicates whether user-supplied weights are provided by you:
 IWT = 1
 Indicates that user-supplied weights are given in the array WT.
 IWT \neq 0
 Indicates that user-supplied weights are not given. In this case the routine assigns the value 1.0 to each element of the weight array, WT.
On exit: is used to indicate the number of valid observations, m ; see Section 3(g), above.
- 5: WT(N) – REAL (KIND=nag_wp) array *Input/Output*
On entry: if weights are being supplied then the elements of WT must contain the weights associated with the observations, w_i , for $i = 1, 2, \dots, n$.
Constraint: if IWT = 1, $WT(i) \geq 0.0$, for $i = 1, 2, \dots, N$.
On exit: if IWT = 1, the elements of WT are unchanged, otherwise each element of WT will be assigned the value 1.0.
- 6: RES(13) – REAL (KIND=nag_wp) array *Output*
On exit: the elements of RES contain the following results:
- | | |
|--------|--|
| RES(1) | mean of the first sample, \bar{x} ; |
| RES(2) | mean of the second sample, \bar{y} ; |
| RES(3) | standard deviation of the first sample, s_1 ; |
| RES(4) | standard deviation of the second sample, s_2 ; |
| RES(5) | corrected sum of squares of the first sample, c_{11} ; |
| RES(6) | corrected sum of products of the two samples, c_{12} ; |

- RES(7) corrected sum of squares of the second sample, c_{22} ;
 RES(8) product-moment correlation coefficient, R ;
 RES(9) minimum of the first sample;
 RES(10) maximum of the first sample;
 RES(11) minimum of the second sample;
 RES(12) maximum of the second sample;
 RES(13) sum of weights, $\sum_{i=1}^n w_i$ ($= N$, if $IWT = 0$, on entry).

7: IFAIL – INTEGER

Input/Output

On entry: IFAIL must be set to 0, -1 or 1. If you are unfamiliar with this argument you should refer to Section 3.4 in How to Use the NAG Library and its Documentation for details.

For environments where it might be inappropriate to halt program execution when an error is detected, the value -1 or 1 is recommended. If the output of error messages is undesirable, then the value 1 is recommended. Otherwise, if you are not familiar with this argument, the recommended value is 0. **When the value -1 or 1 is used it is essential to test the value of IFAIL on exit.**

On exit: IFAIL = 0 unless the routine detects an error or a warning has been flagged (see Section 6).

6 Error Indicators and Warnings

If on entry IFAIL = 0 or -1 , explanatory error messages are output on the current error message unit (as defined by X04AAF).

Errors or warnings detected by the routine:

IFAIL = 1

On entry, $N < 1$.

IFAIL = 2

The number of valid cases, m , is 1, hence the standard deviation, 3(d), and the product-moment correlation coefficient, 3(e), cannot be calculated.

IFAIL = 3

The number of valid cases, m , is 0, or at least one of the weights is negative.

IFAIL = -99

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

See Section 3.9 in How to Use the NAG Library and its Documentation for further information.

IFAIL = -399

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

See Section 3.8 in How to Use the NAG Library and its Documentation for further information.

IFAIL = -999

Dynamic memory allocation failed.

See Section 3.7 in How to Use the NAG Library and its Documentation for further information.

7 Accuracy

The method used is believed to be stable.

8 Parallelism and Performance

G01ABF is not threaded in any implementation.

9 Further Comments

The time taken by G01ABF increases linearly with n .

10 Example

In the program below, NPROB determines the number of datasets to be analysed. For each analysis, a set of observations and, optionally, weights, is read and printed. After calling G01ABF, all the calculated quantities are printed. In the example, there is one set of data, with 29 (unweighted) pairs of observations.

10.1 Program Text

```

Program g01abfe

!      G01ABF Example Program Text

!      Mark 26 Release. NAG Copyright 2016.

!      .. Use Statements ..
      Use nag_library, Only: g01abf, nag_wp
!      .. Implicit None Statement ..
      Implicit None
!      .. Parameters ..
      Integer, Parameter          :: nin = 5, nout = 6
!      .. Local Scalars ..
      Integer                    :: i, ifail, iwt, n
!      .. Local Arrays ..
      Real (Kind=nag_wp)         :: res(13)
      Real (Kind=nag_wp), Allocatable :: wt(:), wtin(:), x1(:), x2(:)
!      .. Executable Statements ..
      Write (nout,*) 'G01ABF Example Program Results'
      Write (nout,*)

!      Skip heading in data file
      Read (nin,*)

!      Read in the problem size
      Read (nin,*) n, iwt

      Allocate (wt(n),wtin(n),x1(n),x2(n))

!      Read in data
      Read (nin,*)(x1(i),x2(i),i=1,n)
      If (iwt==1) Then
         Read (nin,*) wtin(1:n)
         wt(1:n) = wtin(1:n)
      End If

!      Display data
      Write (nout,99999) 'Number of cases', n
      Write (nout,*) 'Data as input -'
      Write (nout,*)
      '          Var 1          Var 2          Var 1          Var 2          Var 1          Var 2          &
      Write (nout,99995)(x1(i),x2(i),i=1,n)
      If (iwt==1) Then
         Write (nout,*) 'Weights as input -'
         Write (nout,99994) wtin(1:n)
      End If
      Write (nout,*)

!      Calculate summary statistics

```

```

ifail = -1
Call g01abf(n,x1,x2,iwt,wt,res,ifail)
If (ifail/=0) Then
  If (ifail/=2) Then
    Go To 100
  End If
End If

! Display results
Write (nout,99999) 'No. of valid cases', iwt
Write (nout,99993) 'Variable 1', 'Variable 2'
Write (nout,99998) 'Mean ', res(1), res(2)
Write (nout,99997) 'Corr SSP', res(5), res(6), res(7)
Write (nout,99998) 'Minimum ', res(9), res(11)
Write (nout,99998) 'Maximum ', res(10), res(12)
Write (nout,99998) 'Sum of weights ', res(13)
If (ifail==0) Then
  Write (nout,99998) 'Std devn', res(3), res(4)
  Write (nout,99996) 'Correln ', res(8)
Else
  Write (nout,*) 'Std devn and Correln not defined'
End If

100 Continue

99999 Format (1X,A,I5)
99998 Format (1X,A,F15.1,F30.1)
99997 Format (1X,A,3E15.5)
99996 Format (1X,A,F30.4)
99995 Format (5X,6F11.1)
99994 Format (13X,F9.3)
99993 Format (13X,A,20X,A)
End Program g01abfe

```

10.2 Program Data

G01ABF Example Program Data

29	0									
350	47	550	95	380	211	510	122	1270	530	
300	38	2630	278	810	309	140	75	450	43	
2280	407	250	142	540	89	720	159	90	35	
480	103	180	78	3160	969	220	120	860	333	
300	73	1460	147	400	30	620	100	120	55	
780	145	230	101	1070	468	160	86			

10.3 Program Results

G01ABF Example Program Results

Number of cases 29

Data as input -

Var 1	Var 2	Var 1	Var 2	Var 1	Var 2
350.0	47.0	550.0	95.0	380.0	211.0
510.0	122.0	1270.0	530.0	300.0	38.0
2630.0	278.0	810.0	309.0	140.0	75.0
450.0	43.0	2280.0	407.0	250.0	142.0
540.0	89.0	720.0	159.0	90.0	35.0
480.0	103.0	180.0	78.0	3160.0	969.0
220.0	120.0	860.0	333.0	300.0	73.0
1460.0	147.0	400.0	30.0	620.0	100.0
120.0	55.0	780.0	145.0	230.0	101.0
1070.0	468.0	160.0	86.0		

No. of valid cases 29

Variable 1

Variable 2

Mean 734.8 185.8

Corr SSP 0.16396E+08 0.34830E+07 0.11319E+07

Minimum	90.0		30.0
Maximum	3160.0		969.0
Sum of weights		29.0	
Std devn	765.2		201.1
Correln		0.8085	
