

# NAG Library Routine Document

## G01AJF

**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

G01AJF prints a histogram on a character printing device, allowing you control over size, positioning, and the range of data values included.

### 2 Specification

```
SUBROUTINE G01AJF (X, N, NSTEPX, NSTEY, ITYPE, ISPACE, XMIN, XMAX,      &
                  XSTEP, N1, MULTY, IFAIL)

INTEGER          N, NSTEPX, NSTEY, ITYPE, ISPACE, N1, MULTY, IFAIL
REAL (KIND=nag_wp) X(N), XMIN, XMAX, XSTEP
```

### 3 Description

A histogram is printed using vertical bars consisting of \* characters. The output is directed to the current advisory message unit (see the Users' Note for your implementation). It may be redirected by a call to X04ABF before calling G01AJF.

The following options are available:

- (a) inclusion of all data values, or only of those lying within a specified range;
- (b) specification of the size of the histogram in the vertical and horizontal directions, and of positioning in the horizontal direction;
- (c) calculation of frequencies or cumulative frequencies in the histogram.

The maximum and minimum data values used, the (integral) number of observations represented by each \* in the histogram, and the step size per character position in the horizontal direction, are returned.

The histogram is headed FREQUENCY or CUM.FREQ. depending on the option selected. Each line is annotated with the minimum frequency which a bar reaching that line represents. The data maximum and minimum are printed under the histogram, unless either exceeds 9999.99 in modulus, in which case they are not printed (although they are still returned).

### 4 References

None.

### 5 Arguments

- |    |   |              |
|----|---|--------------|
| 1: | X(N) – REAL (KIND=nag_wp) array<br><i>On entry:</i> the data values.                          | <i>Input</i> |
| 2: | N – INTEGER<br><i>On entry:</i> the number of data values.<br><i>Constraint:</i> $N \geq 1$ . | <i>Input</i> |

- 3:     NSTEPX – INTEGER *Input/Output*
- On entry:* the number of character positions to be used in the horizontal direction, i.e., the number of categories in the histogram.
- On exit:* if  $\text{NSTEPX} < 10$  on entry, NSTEPX is reset to 10.
- If  $\text{NSTEPX} > 99$  on entry, NSTEPX is reset to 99.
- Otherwise, NSTEPX is unchanged on exit.
- 4:     NSTEPY – INTEGER *Input/Output*
- On entry:* the number of character positions to be used in the vertical direction, i.e., the maximum height of a histogram bar.
- On exit:* if  $\text{NSTEPY} < 10$  on entry, NSTEPY is reset to 10.
- If  $\text{NSTEPY} > 99$  on entry, NSTEPY is reset to 99.
- Otherwise, NSTEPY is unchanged on exit.
- 5:     ITYPE – INTEGER *Input*
- On entry:* indicates whether a histogram of frequencies or cumulative frequencies is required.
- ITYPE = 0 for frequencies.
- ITYPE  $\neq$  0 for cumulative frequencies.
- The second option effectively displays the distribution function of the data rather than the density function.
- 6:     ISPACE – INTEGER *Input/Output*
- On entry:* indicates how many spaces are to be inserted at the beginning of each output line.
- If  $\text{ISPACE} < 0$  on input,  $\text{ISPACE} = 0$  is used
- If  $\text{ISPACE} + \text{NSTEPX} + 14 > 120$ , then  $\text{ISPACE} = 0$  is used.
- The second condition imposes an effective line length limit of 120 characters.
- On exit:* unchanged unless  $\text{ISPACE} < 0$  or  $\text{ISPACE} + \text{NSTEPX} + 14 > 120$ , in which case ISPACE is set to 0.
- 7:     XMIN – REAL (KIND=nag\_wp) *Input/Output*
- 8:     XMAX – REAL (KIND=nag\_wp) *Input/Output*
- On entry:* if  $\text{XMIN} < \text{XMAX}$ , only those values in  $X$  such that  $\text{XMIN} \leq X(i) \leq \text{XMAX}$ , for  $i = 1, 2, \dots, n$ , are included in the histogram.
- If  $\text{XMIN} \geq \text{XMAX}$ , all the data are included.
- On exit:* if  $\text{XMIN} < \text{XMAX}$  on entry, then XMIN and XMAX are unchanged.
- If  $\text{XMIN} \geq \text{XMAX}$  then XMIN and XMAX contain the minimum and maximum data values respectively.
- 9:     XSTEP – REAL (KIND=nag\_wp) *Output*
- On exit:* the width of each class interval.
- 10:    N1 – INTEGER *Output*
- On exit:* the total number of observations actually included in the histogram.
- 11:    MULTY – INTEGER *Output*
- On exit:* the number of observations represented by each \* in the histogram.

## 12: 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 = -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

Accuracy is limited by the number of plotting positions available.

## 8 Parallelism and Performance

G01AJF is not threaded in any implementation.

## 9 Further Comments

The time taken by G01AJF increases with N, NSTEPX and NSTEPLY.

A total of (NSTEPX + ISPACE + 14) character positions are used in the horizontal direction, not including the carriage control character. It is important that this total does not exceed the maximum line length available on the output device.

A total of (NSTEPLY + 3) output lines are normally generated, one less if XMIN and/or XMAX is too large in modulus to be printed.

## 10 Example

A sample of 50 random numbers form the data, which correspond to a Normal distribution with mean and standard deviation both equal to 5.0. A histogram of the entire sample is drawn first, followed by a cumulative histogram of all data values lying between  $-10.0$  and  $5.0$ . The first histogram is indented 10 character positions. Note the use of X04ABF to direct the output to unit number 6.

### 10.1 Program Text

```

Program g01ajfe

!      G01AJF Example Program Text

!      Mark 26 Release. NAG Copyright 2016.

!      .. Use Statements ..
      Use nag_library, Only: g01ajf, nag_wp, x04abf
!      .. Implicit None Statement ..
      Implicit None
!      .. Parameters ..
      Integer, Parameter          :: iset = 1, nin = 5, nout = 6
!      .. Local Scalars ..
      Real (Kind=nag_wp)          :: xmax, xmin, xstep
      Integer                     :: ifail, ispace, itype, multy, n, nl, &
                                   nstepx, nstepy, outchn
!      .. Local Arrays ..
      Real (Kind=nag_wp), Allocatable :: x(:)
!      .. Executable Statements ..
      Write (nout,*) 'G01AJF Example Program Results'
      Write (nout,*)
      Flush (nout)

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

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

      Allocate (x(n))

!      Read in data
      Read (nin,*) x(1:n)

!      Set advisory channel
      outchn = nout
      Call x04abf(iset,outchn)

!      Display histogram
      itype = 0

!      Indent 10 spaces
      ispace = 10

!      Display all the data
      xmin = 0.0E0_nag_wp
      xmax = 0.0E0_nag_wp

!      Produce the plot
      ifail = 0
      Call g01ajf(x,n,nstepx,nstepy,itype,ispace,xmin,xmax,xstep,nl,multy,      &
                 ifail)

      Write (nout,*)
      Write (nout,*)
      Write (nout,*)
      Flush (nout)

!      Display cumulative histogram
      itype = 1

```

```

!      Don't indent
      ispace = 0

!      Display only data between -10 and 5
      xmin = -10.0E0_nag_wp
      xmax = 5.0E0_nag_wp

!      Produce the plot
      ifail = 0
      Call g01ajf(x,n,nstepx,nstepy,itype,isspace,xmin,xmax,xstep,nl,multy,      &
        ifail)

      End Program g01ajfe

```

## 10.2 Program Data

G01AJF Example Program Data

```

50 10 10
  2.68  8.23  0.11  1.39 -2.77 -1.17  3.49  7.39  5.22  5.44
  7.06  6.17 -4.44  5.98 14.02  8.06 10.96  0.99  7.87  4.85
  9.76  3.30  4.45  7.02  5.43  3.57  1.98  3.09 -2.66  5.04
14.52 -0.61  5.04  6.85  3.94  4.87  3.82  5.93  7.89  9.48
  6.81  6.91  7.76  6.21  0.55 -2.44 18.09  6.19  9.19 10.55

```

## 10.3 Program Results

G01AJF Example Program Results

```

      FREQUENCY
      20 . . . 20
      18 . . . 18
      16 . . . 16
      14 . . . 14
      12 . * . 12
      10 . ** . 10
       8 . *** . 8
       6 . *** . 6
       4 . * ***** . 4
       2 . ***** * . 2
      -----
      -4.44      18.09

```

```

CUM. FREQ.
      30 . . . 30
      27 . . . 27
      24 . . . 24
      21 . * . 21
      18 . * . 18
      15 . ** . 15
      12 . ** . 12
       9 . *** . 9
       6 . **** . 6
       3 . ***** . 3
      -----
      -10.00      5.00

```

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