NAG Toolbox

nag_stat_inv_cdf_chisq (g01fc)

1 Purpose

nag_stat_inv_cdf_chisq (g01fc) returns the deviate associated with the given lower tail probability of the χ^2-distribution with real degrees of freedom.

2 Syntax

```
[result, ifail] = nag_stat_inv_cdf_chisq(p, df)
[result, ifail] = g01fc(p, df)
```

3 Description

The deviate, x_p, associated with the lower tail probability p of the χ^2-distribution with ν degrees of freedom is defined as the solution to

$$P\left(X \leq x_p : \nu\right) = p = \frac{1}{2^{\nu/2}\Gamma(\nu/2)}\int_0^{x_p} e^{-X/2}X^{v/2-1}\,dX, \quad 0 \leq x_p < \infty;\nu > 0.$$

The required x_p is found by using the relationship between a χ^2-distribution and a gamma distribution, i.e., a χ^2-distribution with ν degrees of freedom is equal to a gamma distribution with scale parameter 2 and shape parameter $\nu/2$.

For very large values of ν, greater than 10^5, Wilson and Hilferty's normal approximation to the χ^2 is used; see Kendall and Stuart (1969).

4 References

Best D J and Roberts D E (1975) Algorithm AS 91. The percentage points of the χ^2 distribution *Appl. Statist.* **24** 385–388

Hastings N A J and Peacock J B (1975) *Statistical Distributions* Butterworth

Kendall M G and Stuart A (1969) *The Advanced Theory of Statistics (Volume 1)* (3rd Edition) Griffin

5 Parameters

5.1 Compulsory Input Parameters

1: **p** – REAL (KIND=nag_wp)

p, the lower tail probability from the required χ^2-distribution.

Constraint: $0.0 \leq \mathbf{p} < 1.0$.

2: **df** – REAL (KIND=nag_wp)

ν, the degrees of freedom of the χ^2-distribution.

Constraint: $\mathbf{df} > 0.0$.

5.2 Optional Input Parameters

None.

5.3 Output Parameters

1: **result**

The result of the function.

2: **ifail** – INTEGER

ifail $= 0$ unless the function detects an error (see Section 5).

6 Error Indicators and Warnings

Note: nag_stat_inv_cdf_chisq (g01fc) may return useful information for one or more of the following detected errors or warnings.

Errors or warnings detected by the function:

If **ifail** $= 1$, 2, 3 or 5 on exit, then nag_stat_inv_cdf_chisq (g01fc) returns 0.0.

ifail $= 1$

On entry, **p** < 0.0,
or **p** ≥ 1.0.

ifail $= 2$

On entry, **df** ≤ 0.0.

ifail $= 3$

p is too close to 0 or 1 for the result to be calculated.

ifail $= 4$ (*warning*)

The solution has failed to converge. The result should be a reasonable approximation.

ifail $= 5$

The series used to calculate the gamma function has failed to converge. This is an unlikely error exit.

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

The results should be accurate to five significant digits for most argument values. Some accuracy is lost for p close to 0.0.

8 Further Comments

For higher accuracy the relationship described in Section 3 may be used and a direct call to nag_stat_inv_cdf_gamma (g01ff) made.

9 Example

This example reads lower tail probabilities for several χ^2-distributions, and calculates and prints the corresponding deviates until the end of data is reached.

9.1 Program Text

```
     function g01fc_example

fprintf('g01fc example results\n\n');

p    = [ 0.01;   0.428;   0.869];
df   = [20.00;   7.500;  45.000];

fprintf('      p      df       x\n');
for j = 1:numel(p);

  [x, ifail] = g01fc( ...
                      p(j) , df(j));

  fprintf('%9.3f%8.3f%8.3f\n', p(j), df(j), x);
end
```

9.2 Program Results

```
     g01fc example results

       p       df       x
   0.010   20.000   8.260
   0.428    7.500   6.201
   0.869   45.000  55.738
```