

NAG C Library Function Document

nag_deviates_f_dist (g01fdc)

1 Purpose

nag_deviates_f_dist (g01fdc) returns the deviate associated with the given lower tail probability of the F or variance-ratio distribution with real degrees of freedom.

2 Specification

```
#include <nag.h>
#include <nagg01.h>
```

```
double nag_deviates_f_dist (double p, double df1, double df2, NagError *fail)
```

3 Description

The deviate, f_p , associated with the lower tail probability, p , of the F -distribution with degrees of freedom ν_1 and ν_2 is defined as the solution to

$$P(F \leq f_p : \nu_1, \nu_2) = p = \frac{\nu_1^{\frac{1}{2}\nu_1} \nu_2^{\frac{1}{2}\nu_2} \Gamma(\frac{\nu_1+\nu_2}{2})}{\Gamma(\frac{\nu_1}{2}) \Gamma(\frac{\nu_2}{2})} \int_0^{f_p} F^{\frac{1}{2}(\nu_1-2)} (\nu_2 + \nu_1 F)^{-\frac{1}{2}(\nu_1+\nu_2)} dF,$$

where $\nu_1, \nu_2 > 0$; $0 \leq f_p < \infty$.

The value of f_p is computed by means of a transformation to a beta distribution, $P_\beta(B \leq \beta : a, b)$:

$$P(F \leq f : \nu_1, \nu_2) = P_\beta\left(B \leq \frac{\nu_1 f}{\nu_1 f + \nu_2} : \nu_1/2, \nu_2/2\right)$$

and using a call to nag_deviates_beta (g01fec).

For very large values of both ν_1 and ν_2 , greater than 10^5 , a normal approximation is used. If only one of ν_1 or ν_2 is greater than 10^5 then a χ^2 approximation is used, see Abramowitz and Stegun (1972).

4 References

Abramowitz M and Stegun I A (1972) *Handbook of Mathematical Functions* (3rd Edition) Dover Publications

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

5 Arguments

- | | | |
|----|--|--------------|
| 1: | p – double | <i>Input</i> |
| | <i>On entry:</i> the probability, p , from the required F -distribution. | |
| | <i>Constraint:</i> $0.0 \leq \mathbf{p} < 1.0$. | |
| 2: | df1 – double | <i>Input</i> |
| | <i>On entry:</i> the degrees of freedom of the numerator variance, ν_1 . | |
| | <i>Constraint:</i> df1 > 0.0. | |
| 3: | df2 – double | <i>Input</i> |
| | <i>On entry:</i> the degrees of freedom of the denominator variance, ν_2 . | |
| | <i>Constraint:</i> df2 > 0.0. | |

4: **fail** – NagError *

Input/Output

The NAG error parameter, see the Essential Introduction.

6 Error Indicators and Warnings

On any of the error conditions listed below except **NE_SOL_NOT_CONV** nag_deviates_f_dist (g01fdc) returns 0.0.

NE_PROBAB_CLOSE_TO_TAIL

The probability is too close to 0.0 or 1.0. The value of f_p cannot be computed. This will only occur when the large sample approximations are used.

NE_REAL_ARG_GE

On entry, **p** must not be greater than or equal to 1.0: **p** = $\langle value \rangle$.

NE_REAL_ARG_LE

On entry, **df1** must not be less than or equal to 0.0: **df1** = $\langle value \rangle$.

NE_REAL_ARG_LT

On entry, **p** must not be less than 0.0: **p** = $\langle value \rangle$.

NE_SOL_NOT_CONV

The solution has failed to converge. However, the result should be a reasonable approximation. Alternatively, nag_deviates_f_dist (g01fdc) can be used with a suitable setting of the parameter **tol**.

7 Accuracy

The result should be accurate to five significant digits.

8 Further Comments

For higher accuracy nag_deviates_beta (g01fec) can be used along with the transformations given in Section 3.

9 Example

Lower tail probabilities are read for several F -distributions, and the corresponding deviates calculated and printed, until the end of data is reached.

9.1 Program Text

```
/* nag_deviates_f_dist (g01fdc) Example Program.
 *
 * Copyright 1990 Numerical Algorithms Group.
 *
 * Mark 1, 1990.
 */

#include <nag.h>
#include <stdio.h>
#include <nag_stdlib.h>
#include <nagg01.h>

int main(void)
{
    double df1, df2, f, p;
    static NagError fail;
```

```

/* Skip heading in data file */
Vscanf("%*[^\\n]");
Vprintf("nag_deviates_f_dist (g01fdc) Example Program Results\\n");
Vprintf("      p      df1      df2      f\\n\\n");
while (scanf("%lf %lf %lf", &p, &df1, &df2) != EOF)
{
    /* nag_deviates_f_dist (g01fdc).
     * Deviates for the F-distribution
     */
    f = nag_deviates_f_dist(p, df1, df2, &fail);
    if (fail.code==NE_NOERROR)
        Vprintf("%8.3f%8.3f%8.3f%8.3f\\n", p, df1, df2, f);
    else
        Vprintf("%8.3f%8.3f%8.3f%8.3f\\n Note: %s\\n",p,df1,df2,f,
                fail.message);
}
return EXIT_SUCCESS;
}

```

9.2 Program Data

```

nag_deviates_f_dist (g01fdc) Example Program Data
0.9837  10.0   25.5
0.9000  1.0    1.0
0.5342  20.25  1.0

```

9.3 Program Results

```

nag_deviates_f_dist (g01fdc) Example Program Results
      p      df1      df2      f
0.984  10.000  25.500   2.837
0.900   1.000   1.000  39.866
0.534  20.250   1.000   2.500

```
