

nag_prob_chi_sq (g01ecc)

1. Purpose

nag_prob_chi_sq (g01ecc) returns the lower or upper tail probability for the χ^2 distribution with real degrees of freedom.

2. Specification

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

```
double nag_prob_chi_sq(Nag_TailProbability tail, double x, double df,
    NagError *fail)
```

3. Description

The lower tail probability for the χ^2 distribution with ν degrees of freedom, $P(X \leq x : \nu)$, is defined by

$$P(X \leq x : \nu) = \frac{1}{2^{\nu/2}\Gamma(\nu/2)} \int_{0.0}^x X^{\nu/2-1} e^{-X/2} dX \quad x \geq 0, \nu > 0.$$

To calculate $P(X \leq x : \nu)$ a transformation of a gamma distribution is employed, i.e., a χ^2 distribution with ν degrees of freedom is equal to a gamma distribution with scale parameter 2 and shape parameter $\nu/2$.

4. Parameters

tail

Input: indicates whether the upper or lower tail probability is required.

If **tail** = **Nag_LowerTail**, the lower tail probability is returned, i.e., $P(X \leq x : \nu)$.

If **tail** = **Nag_UpperTail**, the upper tail probability is returned, i.e., $P(X \geq x : \nu)$.

Constraint: **tail** = **Nag_LowerTail** or **Nag_UpperTail**.

x

Input: the value of the χ^2 variate, x , with ν degrees of freedom.

Constraint: **x** \geq 0.0.

df

Input: the degrees of freedom, ν , of the χ^2 distribution.

Constraint: **df** $>$ 0.0.

fail

The NAG error parameter, see the Essential Introduction to the NAG C Library.

5. Error Indications and Warnings

On any of the error conditions listed below except **NE_ALG_NOT_CONV** **nag_prob_chi_sq** returns 0.0.

NE_BAD_PARAM

On entry, parameter **tail** had an illegal value.

NE_REAL_ARG_LT

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

NE_REAL_ARG_LE

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

NE_ALG_NOT_CONV

The series used to calculate the gamma probabilities has failed to converge.

The result returned should represent an approximation to the solution.

6. Further Comments

6.1. Accuracy

A relative accuracy of 5 significant figures is obtained in most cases.

6.2. References

Abramowitz M and Stegun I A (1965) *Handbook of Mathematical Functions* Dover Publications, New York.
Hastings N A J and Peacock J B (1975) *Statistical Distributions* Butterworth.

7. See Also

None.

8. Example

Values from various χ^2 distributions are read, the lower-tail probabilities calculated, and all these values printed out, until the end of data is reached.

8.1. Program Text

```

/* nag_prob_chi_sq(g01ecc) Example Program
 *
 * Copyright 1990 Numerical Algorithms Group.
 *
 * Mark 1, 1990.
 */

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

main()
{
    double df, prob, x;
    static NagError fail;

    /* Skip heading in data file */
    Vscanf("%*[^\\n]");
    Vprintf("g01ecc Example Program Results\\n");
    Vprintf(" x      df      prob\\n\\n");
    while (scanf("%lf %lf", &x, &df) != EOF)
    {
        prob = g01ecc(Nag_LowerTail, x, df, &fail);
        if (fail.code==NE_NOERROR)
            Vprintf("%6.3f%8.3f%8.4f\\n", x, df, prob);
        else
        {
            Vprintf("%6.3f%8.3f%8.4f\\n Note: %s\\n", x, df, prob, fail.message);
            exit(EXIT_FAILURE);
        }
    }
    exit(EXIT_SUCCESS);
}

```

8.2. Program Data

```

g01ecc Example Program Data
 8.26  20.0
 6.2   7.5
55.76 45.0

```

8.3. Program Results

```

g01ecc Example Program Results
 x      df      prob
 8.260 20.000 0.0100

```

| | | |
|--------|--------|--------|
| 6.200 | 7.500 | 0.4279 |
| 55.760 | 45.000 | 0.8694 |
