NAG Toolbox for MATLAB

g01ge

1 Purpose

g01ge returns the probability associated with the lower tail of the noncentral beta distribution, via the function name.

2 Syntax

```
[result, ifail] = g01ge(x, a, b, rlamda, tol, 'maxit', maxit)
```

3 Description

The lower tail probability for the noncentral beta distribution with parameters a and b and noncentrality parameter λ, $P(\mathbf{b} \leq \beta : a, b; \lambda)$, is defined by

$$P(B \leq \beta : a, b; \lambda) = \sum_{j=0}^{\infty} e^{-\lambda/2} \frac{(\lambda/2)}{j!} P(B \leq \beta : a, b; 0), \tag{1}$$

where

$$P(B \leq \beta : a, b; 0) = \frac{\Gamma(a+b)}{\Gamma(a)\Gamma(b)} \int_0^{\beta} B^{a-1}(1-B)^{b-1}\, dB,$$

which is the central beta probability function or incomplete beta function.

Recurrence relationships given in Abramowitz and Stegun 1972 are used to compute the values of $P(\mathbf{b} \leq \beta : a, b; 0)$ for each step of the summation (1).

The algorithm is discussed in Lenth 1987.

4 References

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

Lenth R V 1987 Algorithm AS226: Computing noncentral beta probabilities *Appl. Statist.* **36** 241–244

5 Parameters

5.1 Compulsory Input Parameters

1: **x – double scalar**

β, the deviate from the beta distribution, for which the probability $P(\mathbf{b} \leq \beta : a, b; \lambda)$ is to be found.

Constraint: $0.0 \leq \mathbf{x} \leq 1.0$.

2: **a – double scalar**

a, the first parameter of the required beta distribution.

Constraint: $0.0 < \mathbf{a} \leq 10^6$.

3: **b – double scalar**

b, the second parameter of the required beta distribution.

Constraint: $0.0 < \mathbf{b} \leq 10^6$.

4: **rlamda – double scalar**

λ, the noncentrality parameter of the required beta distribution.

Constraint: $0.0 \leq$ **rlamda** $\leq -2.0\log(U)$, where U is the safe range parameter as defined by x02am.

5: **tol – double scalar**

The relative accuracy required by you in the results. If g01ge is entered with **tol** greater than or equal to 1.0 or less than 10 times the ***machine precision*** (see x02aj), then the value of 10 times ***machine precision*** is used instead.

See Section 7 for the relationship between **tol** and **maxit**.

5.2 Optional Input Parameters

1: **maxit – int32 scalar**

The maximum number of iterations that the algorithm should use.

See Section 7 for suggestions as to suitable values for **maxit** for different values of the parameters.

Constraint: **maxit** ≥ 1.

5.3 Input Parameters Omitted from the MATLAB Interface

None.

5.4 Output Parameters

1: **result – double scalar**

The result of the function.

2: **ifail – int32 scalar**

0 unless the function detects an error (see Section 6).

6 Error Indicators and Warnings

Note: g01ge may return useful information for one or more of the following detected errors or warnings.

ifail $= 1$

On entry, **a** ≤ 0.0,
or **a** $> 10^6$,
or **b** ≤ 0.0,
or **b** $> 10^6$,
or **rlamda** < 0.0,
or **rlamda** $> -2.0\log(U)$, where $U =$ safe range parameter as defined by x02am,
or **x** < 0.0,
or **x** > 1.0,
or **maxit** < 1.

If on exit **ifail** $= 1$ then g01ge returns zero.

ifail $= 2$

The solution has failed to converge in **maxit** iterations. You should try a larger value of **maxit** or **tol**. The returned value will be an approximation to the correct value.

ifail $= 3$

The probability is too close to 0.0 or 1.0 for the algorithm to be able to calculate the required probability. g01ge will return 0.0 or 1.0 as appropriate, this should be a reasonable approximation.

ifail $= 4$

The required accuracy was not achieved when calculating the initial value of $P(\mathbf{b} \leq \beta : a, b; \lambda)$. You should try a larger value of **tol**. The returned value will be an approximation to the correct value.

7 Accuracy

Convergence is theoretically guaranteed whenever $P(Y > \mathbf{maxit}) \leq \mathbf{tol}$ where Y has a Poisson distribution with mean $\lambda/2$. Excessive round-off errors are possible when the number of iterations used is high and **tol** is close to ***machine precision***. See Lenth 1987 for further comments on the error bound.

8 Further Comments

The central beta probabilities can be obtained by setting **rlamda** $= 0.0$.

9 Example

```
x = 0.25;
a = 1;
b = 2;
rlamda = 1;
tol = 5e-06;
[result, ifail] = g01ge(x, a, b, rlamda, tol)
```

```
result =
    0.3168
ifail =
           0
```