

NAG Toolbox

nag_stat_prob_beta (g01ee)

1 Purpose

nag_stat_prob_beta (g01ee) computes the upper and lower tail probabilities and the probability density function of the beta distribution with parameters a and b .

2 Syntax

```
[p, q, pdf, ifail] = nag_stat_prob_beta(x, a, b)
[p, q, pdf, ifail] = g01ee(x, a, b)
```

Note: the interface to this routine has changed since earlier releases of the toolbox:

At Mark 23: *tol* was removed from the interface.

3 Description

The probability density function of the beta distribution with parameters a and b is:

$$f(B : a, b) = \frac{\Gamma(a+b)}{\Gamma(a)\Gamma(b)} B^{a-1} (1-B)^{b-1}, \quad 0 \leq B \leq 1; a, b > 0.$$

The lower tail probability, $P(B \leq \beta : a, b)$ is defined by

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

The function $I_x(a, b)$, also known as the incomplete beta function is calculated using nag_specfun_beta_incomplete (s14cc).

4 References

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

5 Parameters

5.1 Compulsory Input Parameters

1: **x** – REAL (KIND=nag_wp)

β , the value of the beta variate.

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

2: **a** – REAL (KIND=nag_wp)

a , the first parameter of the required beta distribution.

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

3: **b** – REAL (KIND=nag_wp)

b , the second parameter of the required beta distribution.

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

5.2 Optional Input Parameters

None.

5.3 Output Parameters

- 1: **p** – REAL (KIND=nag_wp)
The lower tail probability, $P(B \leq \beta : a, b)$.
- 2: **q** – REAL (KIND=nag_wp)
The upper tail probability, $P(B \geq \beta : a, b)$.
- 3: **pdf** – REAL (KIND=nag_wp)
The probability density function, $f(B : a, b)$.
- 4: **ifail** – INTEGER
ifail = 0 unless the function detects an error (see Section 5).

6 Error Indicators and Warnings

Note: nag_stat_prob_beta (g01ee) may return useful information for one or more of the following detected errors or warnings.

Errors or warnings detected by the function:

ifail = 1

On entry, $x < 0.0$,
or $x > 1.0$.

ifail = 2

On entry, $a \leq 0.0$,
or $a > 10^6$,
or $b \leq 0.0$,
or $b > 10^6$.

ifail = 4 (*warning*)

x is too far out into the tails for the probability to be evaluated exactly. The results returned are 0 and 1 as appropriate. These should be a good approximation to the required solution.

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 accuracy is limited by the error in the incomplete beta function. See Section 7 in nag_specfun_beta_incomplete (s14cc) for further details.

8 Further Comments

None.

9 Example

This example reads values from a number of beta distributions and computes the associated upper and lower tail probabilities and the corresponding value of the probability density function.

9.1 Program Text

```
function g01ee_example

fprintf('g01ee example results\n\n');

% Lower and upper tail probabilities for Beta distribution
x = [0.25; 0.75; 0.50];
a = [1.00; 1.50; 2.00];
b = [2.00; 1.50; 1.00];

fprintf('      x      a      b      p      q      pdf\n');
for j = 1:numel(x)

    [p, q, pdf, ifail] = g01ee( ...
                           x(j), a(j), b(j));

    fprintf('%8.4f', x(j), a(j), b(j), p, q, pdf);
    fprintf('\n')
end
```

9.2 Program Results

```
g01ee example results

      x      a      b      p      q      pdf
0.2500  1.0000  2.0000  0.4375  0.5625  1.5000
0.7500  1.5000  1.5000  0.8045  0.1955  1.1027
0.5000  2.0000  1.0000  0.2500  0.7500  1.0000
```
