Statistical functions

Contents Functions References Also see

Contents

`betaden(`a`,`b`,`x`)` the probability density of the beta distribution, where a and b are the shape parameters; `0` if $x < 0$ or $x > 1$

`binomial(`n`,`k`,`θ`)` the probability of observing `floor(`k`)` or fewer successes in `floor(`n`)` trials when the probability of a success on one trial is θ; `0` if $k < 0$; or `1` if $k > n$

`binomialp(`n`,`k`,`p`)` the probability of observing `floor(`k`)` successes in `floor(`n`)` trials when the probability of a success on one trial is p

`binomialtail(`n`,`k`,`θ`)` the probability of observing `floor(`k`)` or more successes in `floor(`n`)` trials when the probability of a success on one trial is θ; `1` if $k < 0$; or `0` if $k > n$

`binormal(`h`,`k`,`ρ`)` the joint cumulative distribution $\Phi(h, k, \rho)$ of bivariate normal with correlation ρ

`cauchy(`a`,`b`,`x`)` the cumulative Cauchy distribution with location parameter a and scale parameter b

`cauchyden(`a`,`b`,`x`)` the probability density of the Cauchy distribution with location parameter a and scale parameter b

`cauchytail(`a`,`b`,`x`)` the reverse cumulative (upper tail or survivor) Cauchy distribution with location parameter a and scale parameter b

`chi2(`*df*`,`x`)` the cumulative χ^2 distribution with *df* degrees of freedom; `0` if $x < 0$

`chi2den(`*df*`,`x`)` the probability density of the chi-squared distribution with *df* degrees of freedom; `0` if $x < 0$

`chi2tail(`*df*`,`x`)` the reverse cumulative (upper tail or survivor) χ^2 distribution with *df* degrees of freedom; `1` if $x < 0$

`dgammapda(`a`,`x`)` $\frac{\partial P(a,x)}{\partial a}$, where $P(a, x) =$ `gammap(`a`,`x`)`; `0` if $x < 0$

`dgammapdada(`a`,`x`)` $\frac{\partial^2 P(a,x)}{\partial a^2}$, where $P(a, x) =$ `gammap(`a`,`x`)`; `0` if $x < 0$

`dgammapdadx(`a`,`x`)` $\frac{\partial^2 P(a,x)}{\partial a \partial x}$, where $P(a, x) =$ `gammap(`a`,`x`)`; `0` if $x < 0$

`dgammapdx(`a`,`x`)` $\frac{\partial P(a,x)}{\partial x}$, where $P(a, x) =$ `gammap(`a`,`x`)`; `0` if $x < 0$

`dgammapdxdx(`a`,`x`)` $\frac{\partial^2 P(a,x)}{\partial x^2}$, where $P(a, x) =$ `gammap(`a`,`x`)`; `0` if $x < 0$

`dunnettprob(`k`,`*df*`,`x`)` the cumulative multiple range distribution that is used in Dunnett's multiple-comparison method with k ranges and *df* degrees of freedom; `0` if $x < 0$

`exponential(`b`,`x`)` the cumulative exponential distribution with scale b

`exponentialden(`b`,`x`)` the probability density function of the exponential distribution with scale b

`exponentialtail(`b`,`x`)` the reverse cumulative exponential distribution with scale b

F(df_1,df_2,f) the cumulative F distribution with df_1 numerator and df_2 denominator degrees of freedom: F(df_1,df_2,f) $= \int_0^f$ Fden(df_1,df_2,t) dt; 0 if $f < 0$

Fden(df_1,df_2,f) the probability density function of the F distribution with df_1 numerator and df_2 denominator degrees of freedom; 0 if $f < 0$

Ftail(df_1,df_2,f) the reverse cumulative (upper tail or survivor) F distribution with df_1 numerator and df_2 denominator degrees of freedom; 1 if $f < 0$

gammaden(a,b,g,x) the probability density function of the gamma distribution; 0 if $x < g$

gammap(a,x) the cumulative gamma distribution with shape parameter a; 0 if $x < 0$

gammaptail(a,x) the reverse cumulative (upper tail or survivor) gamma distribution with shape parameter a; 1 if $x < 0$

hypergeometric(N,K,n,k) the cumulative probability of the hypergeometric distribution

hypergeometricp(N,K,n,k) the hypergeometric probability of k successes out of a sample of size n, from a population of size N containing K elements that have the attribute of interest

ibeta(a,b,x) the cumulative beta distribution with shape parameters a and b; 0 if $x < 0$; or 1 if $x > 1$

ibetatail(a,b,x) the reverse cumulative (upper tail or survivor) beta distribution with shape parameters a and b; 1 if $x < 0$; or 0 if $x > 1$

igaussian(m,a,x) the cumulative inverse Gaussian distribution with mean m and shape parameter a; 0 if $x \leq 0$

igaussianden(m,a,x) the probability density of the inverse Gaussian distribution with mean m and shape parameter a; 0 if $x \leq 0$

igaussiantail(m,a,x) the reverse cumulative (upper tail or survivor) inverse Gaussian distribution with mean m and shape parameter a; 1 if $x \leq 0$

invbinomial(n,k,p) the inverse of the cumulative binomial; that is, θ ($\theta =$ probability of success on one trial) such that the probability of observing floor(k) or fewer successes in floor(n) trials is p

invbinomialtail(n,k,p) the inverse of the right cumulative binomial; that is, θ ($\theta =$ probability of success on one trial) such that the probability of observing floor(k) or more successes in floor(n) trials is p

invcauchy(a,b,p) the inverse of cauchy(): if cauchy(a,b,x) $= p$, then invcauchy(a,b,p) $= x$

invcauchytail(a,b,p) the inverse of cauchytail(): if cauchytail(a,b,x) $= p$, then invcauchytail(a,b,p) $= x$

invchi2(df,p) the inverse of chi2(): if chi2(df,x) $= p$, then invchi2(df,p) $= x$

invchi2tail(df,p) the inverse of chi2tail(): if chi2tail(df,x) $= p$, then invchi2tail(df,p) $= x$

invdunnettprob(k,df,p) the inverse cumulative multiple range distribution that is used in Dunnett's multiple-comparison method with k ranges and df degrees of freedom

invexponential(b,p) the inverse cumulative exponential distribution with scale b: if exponential(b,x) $= p$, then invexponential(b,p) $= x$

`invexponentialtail(`b`,`p`)` the inverse reverse cumulative exponential distribution with scale b: if `exponentialtail(`b`,`x`)` $= p$, then `invexponentialtail(`b`,`p`)` $= x$

`invF(`df_1`,`df_2`,`p`)` the inverse cumulative F distribution: if `F(`df_1`,`df_2`,`f`)` $= p$, then `invF(`df_1`,`df_2`,`p`)` $= f$

`invFtail(`df_1`,`df_2`,`p`)` the inverse reverse cumulative (upper tail or survivor) F distribution: if `Ftail(`df_1`,`df_2`,`f`)` $= p$, then `invFtail(`df_1`,`df_2`,`p`)` $= f$

`invgammap(`a`,`p`)` the inverse cumulative gamma distribution: if `gammap(`a`,`x`)` $= p$, then `invgammap(`a`,`p`)` $= x$

`invgammaptail(`a`,`p`)` the inverse reverse cumulative (upper tail or survivor) gamma distribution: if `gammaptail(`a`,`x`)` $= p$, then `invgammaptail(`a`,`p`)` $= x$

`invibeta(`a`,`b`,`p`)` the inverse cumulative beta distribution: if `ibeta(`a`,`b`,`x`)` $= p$, then `invibeta(`a`,`b`,`p`)` $= x$

`invibetatail(`a`,`b`,`p`)` the inverse reverse cumulative (upper tail or survivor) beta distribution: if `ibetatail(`a`,`b`,`x`)` $= p$, then `invibetatail(`a`,`b`,`p`)` $= x$

`invigaussian(`m`,`a`,`p`)` the inverse of `igaussian()`: if `igaussian(`m`,`a`,`x`)` $= p$, then `invigaussian(`m`,`a`,`p`)` $= x$

`invigaussiantail(`m`,`a`,`p`)` the inverse of `igaussiantail()`: if `igaussiantail(`m`,`a`,`x`)` $= p$, then `invigaussiantail(`m`,`a`,`p`)` $= x$

`invlaplace(`m`,`b`,`p`)` the inverse of `laplace()`: if `laplace(`m`,`b`,`x`)` $= p$, then `invlaplace(`m`,`b`,`p`)` $= x$

`invlaplacetail(`m`,`b`,`p`)` the inverse of `laplacetail()`: if `laplacetail(`m`,`b`,`x`)` $= p$, then `invlaplacetail(`m`,`b`,`p`)` $= x$

`invlogistic(`p`)` the inverse cumulative logistic distribution: if `logistic(`x`)` $= p$, then `invlogistic(`p`)` $= x$

`invlogistic(`s`,`p`)` the inverse cumulative logistic distribution: if `logistic(`s`,`x`)` $= p$, then `invlogistic(`s`,`p`)` $= x$

`invlogistic(`m`,`s`,`p`)` the inverse cumulative logistic distribution: if `logistic(`m`,`s`,`x`)` $= p$, then `invlogistic(`m`,`s`,`p`)` $= x$

`invlogistictail(`p`)` the inverse reverse cumulative logistic distribution: if `logistictail(`x`)` $= p$, then `invlogistictail(`p`)` $= x$

`invlogistictail(`s`,`p`)` the inverse reverse cumulative logistic distribution: if `logistictail(`s`,`x`)` $= p$, then `invlogistictail(`s`,`p`)` $= x$

`invlogistictail(`m`,`s`,`p`)` the inverse reverse cumulative logistic distribution: if `logistictail(`m`,`s`,`x`)` $= p$, then `invlogistictail(`m`,`s`,`p`)` $= x$

`invnbinomial(`n`,`k`,`q`)` the value of the negative binomial parameter, p, such that $q =$ `nbinomial(`n`,`k`,`p`)`

`invnbinomialtail(`n`,`k`,`q`)` the value of the negative binomial parameter, p, such that $q =$ `nbinomialtail(`n`,`k`,`p`)`

`invnchi2(`df`,`np`,`p`)` the inverse cumulative noncentral χ^2 distribution: if `nchi2(`df`,`np`,`x`)` $= p$, then `invnchi2(`df`,`np`,`p`)` $= x$

`invnchi2tail(`df`,`np`,`p`)` the inverse reverse cumulative (upper tail or survivor) noncentral χ^2 distribution: if `nchi2tail(`df`,`np`,`x`)` $= p$, then `invnchi2tail(`df`,`np`,`p`)` $= x$

`invnF(`df_1`,`df_2`,`np`,`p`)` the inverse cumulative noncentral F distribution: if `nF(`df_1`,`df_2`,`np`,`f`)` $= p$, then `invnF(`df_1`,`df_2`,`np`,`p`)` $= f$

`invnFtail(`df_1`,`df_2`,`np`,`p`)` the inverse reverse cumulative (upper tail or survivor) noncentral F distribution: if `nFtail(`df_1`,`df_2`,`np`,`f`)` $= p$, then `invnFtail(`df_1`,`df_2`,`np`,`p`)` $= f$

`invnibeta(`a`,`b`,`np`,`p`)` the inverse cumulative noncentral beta distribution: if `nibeta(`a`,`b`,`np`,`x`)` $= p$, then `invibeta(`a`,`b`,`np`,`p`)` $= x$

`invnormal(`p`)` the inverse cumulative standard normal distribution: if `normal(`z`)` $= p$, then `invnormal(`p`)` $= z$

`invnt(`df`,`np`,`p`)` the inverse cumulative noncentral Student's t distribution: if `nt(`df`,`np`,`t`)` $= p$, then `invnt(`df`,`np`,`p`)` $= t$

`invnttail(`df`,`np`,`p`)` the inverse reverse cumulative (upper tail or survivor) noncentral Student's t distribution: if `nttail(`df`,`np`,`t`)` $= p$, then `invnttail(`df`,`np`,`p`)` $= t$

`invpoisson(`k`,`p`)` the Poisson mean such that the cumulative Poisson distribution evaluated at k is p: if `poisson(`m`,`k`)` $= p$, then `invpoisson(`k`,`p`)` $= m$

`invpoissontail(`k`,`q`)` the Poisson mean such that the reverse cumulative Poisson distribution evaluated at k is q: if `poissontail(`m`,`k`)` $= q$, then `invpoissontail(`k`,`q`)` $= m$

`invt(`df`,`p`)` the inverse cumulative Student's t distribution: if `t(`df`,`t`)` $= p$, then `invt(`df`,`p`)` $= t$

`invttail(`df`,`p`)` the inverse reverse cumulative (upper tail or survivor) Student's t distribution: if `ttail(`df`,`t`)` $= p$, then `invttail(`df`,`p`)` $= t$

`invtukeyprob(`k`,`df`,`p`)` the inverse cumulative Tukey's Studentized range distribution with k ranges and df degrees of freedom

`invweibull(`a`,`b`,`p`)` the inverse cumulative Weibull distribution with shape a and scale b: if `weibull(`a`,`b`,`x`)` $= p$, then `invweibull(`a`,`b`,`p`)` $= x$

`invweibull(`a`,`b`,`g`,`p`)` the inverse cumulative Weibull distribution with shape a, scale b, and location g: if `weibull(`a`,`b`,`g`,`x`)` $= p$, then `invweibull(`a`,`b`,`g`,`p`)` $= x$

`invweibullph(`a`,`b`,`p`)` the inverse cumulative Weibull (proportional hazards) distribution with shape a and scale b: if `weibullph(`a`,`b`,`x`)` $= p$, then `invweibullph(`a`,`b`,`p`)` $= x$

`invweibullph(`a`,`b`,`g`,`p`)` the inverse cumulative Weibull (proportional hazards) distribution with shape a, scale b, and location g: if `weibullph(`a`,`b`,`g`,`x`)` $=$ p, then `invweibullph(`a`,`b`,`g`,`p`)` $= x$

`invweibullphtail(`a`,`b`,`p`)` the inverse reverse cumulative Weibull (proportional hazards) distribution with shape a and scale b: if `weibullphtail(`a`,`b`,`x`)` $= p$, then `invweibullphtail(`a`,`b`,`p`)` $= x$

`invweibullphtail(`a`,`b`,`g`,`p`)` the inverse reverse cumulative Weibull (proportional hazards) distribution with shape a, scale b, and location g: if `weibullphtail(`a`,`b`,`g`,`x`)` $= p$, then `invweibullphtail(`a`,`b`,`g`,`p`)` $= x$

`invweibulltail(`a`,`b`,`p`)` the inverse reverse cumulative Weibull distribution with shape a and scale b: if `weibulltail(`a`,`b`,`x`)` $= p$, then `invweibulltail(`a`,`b`,`p`)` $= x$

`invweibulltail(`a`,`b`,`g`,`p`)` the inverse reverse cumulative Weibull distribution with shape a, scale b, and location g: if `weibulltail(`a`,`b`,`g`,`x`)` $= p$, then `invweibulltail(`a`,`b`,`g`,`p`)` $= x$

`laplace(`m`,`b`,`x`)`	the cumulative Laplace distribution with mean m and scale parameter b
`laplaceden(`m`,`b`,`x`)`	the probability density of the Laplace distribution with mean m and scale parameter b
`laplacetail(`m`,`b`,`x`)`	the reverse cumulative (upper tail or survivor) Laplace distribution with mean m and scale parameter b
`lncauchyden(`a`,`b`,`x`)`	the natural logarithm of the density of the Cauchy distribution with location parameter a and scale parameter b
`lnigammaden(`a`,`b`,`x`)`	the natural logarithm of the inverse gamma density, where a is the shape parameter and b is the scale parameter
`lnigaussianden(`m`,`a`,`x`)`	the natural logarithm of the inverse Gaussian density with mean m and shape parameter a
`lniwishartden(`df`,`V`,`X`)`	the natural logarithm of the density of the inverse Wishart distribution; missing if $df \leq n-1$
`lnlaplaceden(`m`,`b`,`x`)`	the natural logarithm of the density of the Laplace distribution with mean m and scale parameter b
`lnmvnormalden(`M`,`V`,`X`)`	the natural logarithm of the multivariate normal density
`lnnormal(`z`)`	the natural logarithm of the cumulative standard normal distribution
`lnnormalden(`z`)`	the natural logarithm of the standard normal density, $N(0,1)$
`lnnormalden(`x`,`σ`)`	the natural logarithm of the normal density with mean 0 and standard deviation σ
`lnnormalden(`x`,`μ`,`σ`)`	the natural logarithm of the normal density with mean μ and standard deviation σ, $N(\mu,\sigma^2)$
`lnwishartden(`df`,`V`,`X`)`	the natural logarithm of the density of the Wishart distribution; missing if $df \leq n-1$
`logistic(`x`)`	the cumulative logistic distribution with mean 0 and standard deviation $\pi/\sqrt{3}$
`logistic(`s`,`x`)`	the cumulative logistic distribution with mean 0, scale s, and standard deviation $s\pi/\sqrt{3}$
`logistic(`m`,`s`,`x`)`	the cumulative logistic distribution with mean m, scale s, and standard deviation $s\pi/\sqrt{3}$
`logisticden(`x`)`	the density of the logistic distribution with mean 0 and standard deviation $\pi/\sqrt{3}$
`logisticden(`s`,`x`)`	the density of the logistic distribution with mean 0, scale s, and standard deviation $s\pi/\sqrt{3}$
`logisticden(`m`,`s`,`x`)`	the density of the logistic distribution with mean m, scale s, and standard deviation $s\pi/\sqrt{3}$
`logistictail(`x`)`	the reverse cumulative logistic distribution with mean 0 and standard deviation $\pi/\sqrt{3}$
`logistictail(`s`,`x`)`	the reverse cumulative logistic distribution with mean 0, scale s, and standard deviation $s\pi/\sqrt{3}$
`logistictail(`m`,`s`,`x`)`	the reverse cumulative logistic distribution with mean m, scale s, and standard deviation $s\pi/\sqrt{3}$
`nbetaden(`a`,`b`,`np`,`x`)`	the probability density function of the noncentral beta distribution; `0` if $x < 0$ or $x > 1$
`nbinomial(`n`,`k`,`p`)`	the cumulative probability of the negative binomial distribution

nbinomialp(n,k,p)	the negative binomial probability
nbinomialtail(n,k,p)	the reverse cumulative probability of the negative binomial distribution
nchi2(df,np,x)	the cumulative noncentral χ^2 distribution; 0 if $x < 0$
nchi2den(df,np,x)	the probability density of the noncentral χ^2 distribution; 0 if $x < 0$
nchi2tail(df,np,x)	the reverse cumulative (upper tail or survivor) noncentral χ^2 distribution; 1 if $x < 0$
nF(df_1,df_2,np,f)	the cumulative noncentral F distribution with df_1 numerator and df_2 denominator degrees of freedom and noncentrality parameter np; 0 if $f < 0$
nFden(df_1,df_2,np,f)	the probability density function of the noncentral F distribution with df_1 numerator and df_2 denominator degrees of freedom and noncentrality parameter np; 0 if $f < 0$
nFtail(df_1,df_2,np,f)	the reverse cumulative (upper tail or survivor) noncentral F distribution with df_1 numerator and df_2 denominator degrees of freedom and noncentrality parameter np; 1 if $f < 0$
nibeta(a,b,np,x)	the cumulative noncentral beta distribution; 0 if $x < 0$; or 1 if $x > 1$
normal(z)	the cumulative standard normal distribution
normalden(z)	the standard normal density, $N(0,1)$
normalden(x,σ)	the normal density with mean 0 and standard deviation σ
normalden(x,μ,σ)	the normal density with mean μ and standard deviation σ, $N(\mu,\sigma^2)$
npnchi2(df,x,p)	the noncentrality parameter, np, for noncentral χ^2: if nchi2(df,np,x) $= p$, then npnchi2(df,x,p) $= np$
npnF(df_1,df_2,f,p)	the noncentrality parameter, np, for the noncentral F: if nF(df_1,df_2,np,f) $= p$, then npnF(df_1,df_2,f,p) $= np$
npnt(df,t,p)	the noncentrality parameter, np, for the noncentral Student's t distribution: if nt(df,np,t) $= p$, then npnt(df,t,p) $= np$
nt(df,np,t)	the cumulative noncentral Student's t distribution with df degrees of freedom and noncentrality parameter np
ntden(df,np,t)	the probability density function of the noncentral Student's t distribution with df degrees of freedom and noncentrality parameter np
nttail(df,np,t)	the reverse cumulative (upper tail or survivor) noncentral Student's t distribution with df degrees of freedom and noncentrality parameter np
poisson(m,k)	the probability of observing floor(k) or fewer outcomes that are distributed as Poisson with mean m
poissonp(m,k)	the probability of observing floor(k) outcomes that are distributed as Poisson with mean m
poissontail(m,k)	the probability of observing floor(k) or more outcomes that are distributed as Poisson with mean m
t(df,t)	the cumulative Student's t distribution with df degrees of freedom
tden(df,t)	the probability density function of Student's t distribution
ttail(df,t)	the reverse cumulative (upper tail or survivor) Student's t distribution; the probability $T > t$
tukeyprob(k,df,x)	the cumulative Tukey's Studentized range distribution with k ranges and df degrees of freedom; 0 if $x < 0$

weibull(a,b,x) the cumulative Weibull distribution with shape a and scale b

weibull(a,b,g,x) the cumulative Weibull distribution with shape a, scale b, and location g

weibullden(a,b,x) the probability density function of the Weibull distribution with shape a and scale b

weibullden(a,b,g,x) the probability density function of the Weibull distribution with shape a, scale b, and location g

weibullph(a,b,x) the cumulative Weibull (proportional hazards) distribution with shape a and scale b

weibullph(a,b,g,x) the cumulative Weibull (proportional hazards) distribution with shape a, scale b, and location g

weibullphden(a,b,x) the probability density function of the Weibull (proportional hazards) distribution with shape a and scale b

weibullphden(a,b,g,x) the probability density function of the Weibull (proportional hazards) distribution with shape a, scale b, and location g

weibullphtail(a,b,x) the reverse cumulative Weibull (proportional hazards) distribution with shape a and scale b

weibullphtail(a,b,g,x) the reverse cumulative Weibull (proportional hazards) distribution with shape a, scale b, and location g

weibulltail(a,b,x) the reverse cumulative Weibull distribution with shape a and scale b

weibulltail(a,b,g,x) the reverse cumulative Weibull distribution with shape a, scale b, and location g

Functions

Statistical functions are listed alphabetically under the following headings:

Beta and noncentral beta distributions

`betaden(`a`,`b`,`x`)`

Description: the probability density of the beta distribution, where a and b are the shape parameters; `0` if $x < 0$ or $x > 1$

The probability density of the beta distribution is

$$\texttt{betaden}(a,b,x) = \frac{x^{a-1}(1-x)^{b-1}}{\int_0^\infty t^{a-1}(1-t)^{b-1}dt} = \frac{\Gamma(a+b)}{\Gamma(a)\Gamma(b)}x^{a-1}(1-x)^{b-1}$$

Domain a: 1e–323 to 8e+307
Domain b: 1e–323 to 8e+307
Domain x: $-$8e+307 to 8e+307; interesting domain is $0 \leq x \leq 1$
Range: 0 to 8e+307

`ibeta(`a`,`b`,`x`)`

Description: the cumulative beta distribution with shape parameters a and b; `0` if $x < 0$; or `1` if $x > 1$

The cumulative beta distribution with shape parameters a and b is defined by

$$I_x(a,b) = \frac{\Gamma(a+b)}{\Gamma(a)\Gamma(b)} \int_0^x t^{a-1}(1-t)^{b-1}\,dt$$

`ibeta()` returns the regularized incomplete beta function, also known as the incomplete beta function ratio. The incomplete beta function without regularization is given by `(gamma(`a`)*gamma(`b`)/gamma(`a`+`b`))*ibeta(`a`,`b`,`x`)` or, better when a or b might be large, `exp(lngamma(`a`)+lngamma(`b`)-lngamma(`a`+`b`))*ibeta(`a`,`b`,`x`)`.

Here is an example of the use of the regularized incomplete beta function. Although Stata has a cumulative binomial function (see `binomial()`), the probability that an event occurs k or fewer times in n trials, when the probability of one event is p, can be evaluated as `cond(`k`==`n`,1,1-ibeta(`k`+1,`n`-`k`,`p`))`. The reverse cumulative binomial (the probability that an event occurs k or more times) can be evaluated as `cond(`k`==0,1,ibeta(`k`,`n`-`k`+1,`p`))`. See Press et al. (2007, 270–273) for a more complete description and for suggested uses for this function.

Domain a: 1e–10 to 1e+17
Domain b: 1e–10 to 1e+17
Domain x: −8e+307 to 8e+307; interesting domain is $0 \leq x \leq 1$
Range: 0 to 1

`ibetatail(`a`,`b`,`x`)`

Description: the reverse cumulative (upper tail or survivor) beta distribution with shape parameters a and b; `1` if $x < 0$; or `0` if $x > 1$

The reverse cumulative (upper tail or survivor) beta distribution with shape parameters a and b is defined by

$$\texttt{ibetatail(}a\texttt{,}b\texttt{,}x\texttt{)} = 1 - \texttt{ibeta(}a\texttt{,}b\texttt{,}x\texttt{)} = \int_x^1 \texttt{betaden(}a\texttt{,}b\texttt{,}t\texttt{)}\,dt$$

`ibetatail()` is also known as the complement to the incomplete beta function (ratio).

Domain a: 1e–10 to 1e+17
Domain b: 1e–10 to 1e+17
Domain x: −8e+307 to 8e+307; interesting domain is $0 \leq x \leq 1$
Range: 0 to 1

`invibeta(`a`,`b`,`p`)`

Description: the inverse cumulative beta distribution: if `ibeta(`a`,`b`,`x`)` $= p$, then `invibeta(`a`,`b`,`p`)` $= x$

Domain a: 1e–10 to 1e+17
Domain b: 1e–10 to 1e+17
Domain p: 0 to 1
Range: 0 to 1

`invibetatail(`a`,`b`,`p`)`

Description: the inverse reverse cumulative (upper tail or survivor) beta distribution: if `ibetatail(`a`,`b`,`x`)` $= p$, then `invibetatail(`a`,`b`,`p`)` $= x$

Domain a: 1e–10 to 1e+17

Domain b: 1e–10 to 1e+17

Domain p: 0 to 1

Range: 0 to 1

`nbetaden(`a`,`b`,`np`,`x`)`

Description: the probability density function of the noncentral beta distribution; `0` if $x < 0$ or $x > 1$

The probability density function of the noncentral beta distribution is defined as

$$\sum_{j=0}^{\infty} \frac{e^{-np/2}(np/2)^j}{\Gamma(j+1)} \left\{ \frac{\Gamma(a+b+j)}{\Gamma(a+j)\Gamma(b)} x^{a+j-1}(1-x)^{b-1} \right\}$$

where a and b are shape parameters, np is the noncentrality parameter, and x is the value of a beta random variable.

`nbetaden(`a`,`b`,0,`x`)` = `betaden(`a`,`b`,`x`)`, but `betaden()` is the preferred function to use for the central beta distribution. `nbetaden()` is computed using an algorithm described in Johnson, Kotz, and Balakrishnan (1995).

Domain a: 1e–323 to 8e+307

Domain b: 1e–323 to 8e+307

Domain np: 0 to 1,000

Domain x: $-$8e+307 to 8e+307; interesting domain is $0 \le x \le 1$

Range: 0 to 8e+307

`nibeta(`a`,`b`,`np`,`x`)`

Description: the cumulative noncentral beta distribution; `0` if $x < 0$; or `1` if $x > 1$

The cumulative noncentral beta distribution is defined as

$$I_x(a,b,np) = \sum_{j=0}^{\infty} \frac{e^{-np/2}(np/2)^j}{\Gamma(j+1)} I_x(a+j,b)$$

where a and b are shape parameters, np is the noncentrality parameter, x is the value of a beta random variable, and $I_x(a,b)$ is the cumulative beta distribution, `ibeta()`.

`nibeta(`a`,`b`,0,`x`)` = `ibeta(`a`,`b`,`x`)`, but `ibeta()` is the preferred function to use for the central beta distribution. `nibeta()` is computed using an algorithm described in Johnson, Kotz, and Balakrishnan (1995).

Domain a: 1e–323 to 8e+307

Domain b: 1e–323 to 8e+307

Domain np: 0 to 10,000

Domain x: $-$8e+307 to 8e+307; interesting domain is $0 \le x \le 1$

Range: 0 to 1

`invnibeta(`a`,`b`,`np`,`p`)`

Description: the inverse cumulative noncentral beta distribution: if `nibeta(`a`,`b`,`np`,`x`)` $= p$, then `invibeta(`a`,`b`,`np`,`p`)` $= x$

Domain a: 1e–323 to 8e+307

Domain b: 1e–323 to 8e+307

Domain np: 0 to 1,000

Domain p: 0 to 1

Range: 0 to 1

Binomial distribution

`binomialp(`n`,`k`,`p`)`

Description: the probability of observing `floor(`k`)` successes in `floor(`n`)` trials when the probability of a success on one trial is p

Domain n: 1 to 1e+6

Domain k: 0 to n

Domain p: 0 to 1

Range: 0 to 1

`binomial(`n`,`k`,`θ`)`

Description: the probability of observing `floor(`k`)` or fewer successes in `floor(`n`)` trials when the probability of a success on one trial is θ; `0` if $k < 0$; or `1` if $k > n$

Domain n: 0 to 1e+17

Domain k: $-$8e+307 to 8e+307; interesting domain is $0 \leq k < n$

Domain θ: 0 to 1

Range: 0 to 1

`binomialtail(`n`,`k`,`θ`)`

Description: the probability of observing `floor(`k`)` or more successes in `floor(`n`)` trials when the probability of a success on one trial is θ; `1` if $k < 0$; or `0` if $k > n$

Domain n: 0 to 1e+17

Domain k: $-$8e+307 to 8e+307; interesting domain is $0 \leq k < n$

Domain θ: 0 to 1

Range: 0 to 1

`invbinomial(`n`,`k`,`p`)`

Description: the inverse of the cumulative binomial; that is, θ (θ = probability of success on one trial) such that the probability of observing `floor(`k`)` or fewer successes in `floor(`n`)` trials is p

Domain n: 1 to 1e+17

Domain k: 0 to $n-1$

Domain p: 0 to 1 (exclusive)

Range: 0 to 1

`invbinomialtail(`n`,`k`,`p`)`

Description: the inverse of the right cumulative binomial; that is, θ (θ = probability of success on one trial) such that the probability of observing `floor(`k`)` or more successes in `floor(`n`)` trials is p
Domain n: 1 to 1e+17
Domain k: 1 to n
Domain p: 0 to 1 (exclusive)
Range: 0 to 1

Cauchy distribution

`cauchyden(`a`,`b`,`x`)`

Description: the probability density of the Cauchy distribution with location parameter a and scale parameter b
Domain a: $-$1e+300 to 1e+300
Domain b: 1e–100 to 1e+300
Domain x: $-$8e+307 to 8e+307
Range: 0 to 8e+307

`cauchy(`a`,`b`,`x`)`

Description: the cumulative Cauchy distribution with location parameter a and scale parameter b
Domain a: $-$1e+300 to 1e+300
Domain b: 1e–100 to 1e+300
Domain x: $-$8e+307 to 8e+307
Range: 0 to 1

`cauchytail(`a`,`b`,`x`)`

Description: the reverse cumulative (upper tail or survivor) Cauchy distribution with location parameter a and scale parameter b
`cauchytail(`a`,`b`,`x`)` $= 1 -$ `cauchy(`a`,`b`,`x`)`
Domain a: $-$1e+300 to 1e+300
Domain b: 1e–100 to 1e+300
Domain x: $-$8e+307 to 8e+307
Range: 0 to 1

`invcauchy(`a`,`b`,`p`)`

Description: the inverse of `cauchy()`: if `cauchy(`a`,`b`,`x`)` $= p$, then `invcauchy(`a`,`b`,`p`)` $= x$
Domain a: $-$1e+300 to 1e+300
Domain b: 1e–100 to 1e+300
Domain p: 0 to 1 (exclusive)
Range: $-$8e+307 to 8e+307

`invcauchytail(`a`,`b`,`p`)`

Description: the inverse of `cauchytail()`: if `cauchytail(`a`,`b`,`x`)` $= p$, then `invcauchytail(`a`,`b`,`p`)` $= x$

Domain a: $-1e+300$ to $1e+300$

Domain b: 1e–100 to 1e+300

Domain p: 0 to 1 (exclusive)

Range: $-8e+307$ to 8e+307

`lncauchyden(`a`,`b`,`x`)`

Description: the natural logarithm of the density of the Cauchy distribution with location parameter a and scale parameter b

Domain a: $-1e+300$ to 1e+300

Domain b: 1e–100 to 1e+300

Domain x: $-8e+307$ to 8e+307

Range: -1650 to 230

Augustin-Louis Cauchy (1789–1857) was born in Paris, France. He obtained a degree in engineering with honors from École Polytechnique, where he would later teach mathematics. While working as a military engineer, he published two papers on polyhedra, one of which was a solution to a problem presented to him by Joseph-Louis Lagrange. In 1816, he won the Grand Prix for his work on wave propagation.

Cauchy's contributions were numerous and far reaching, as evident by the many concepts and theorems named after him. Some examples include the Cauchy criterion for convergence, Cauchy's theorem for finite groups, the Cauchy distribution, and the Cauchy stress tensor. His contributions were so vast that once all of his work was collected, it comprised 27 volumes. His name is engraved on the Eiffel Tower, along with 71 other scientists and mathematicians.

Chi-squared and noncentral chi-squared distributions

`chi2den(`df`,`x`)`

Description: the probability density of the chi-squared distribution with df degrees of freedom; 0 if $x < 0$

`chi2den(`df`,`x`)` $=$ `gammaden(`$df/2$`,2,0,`x`)`

Domain df: 2e–10 to 2e+17 (may be nonintegral)

Domain x: $-8e+307$ to 8e+307

Range: 0 to 8e+307

`chi2(`df`,`x`)`

Description: the cumulative χ^2 distribution with df degrees of freedom; 0 if $x < 0$

`chi2(`df`,`x`)` $=$ `gammap(`$df/2$`,`$x/2$`)`

Domain df: 2e–10 to 2e+17 (may be nonintegral)

Domain x: $-8e+307$ to 8e+307; interesting domain is $x \geq 0$

Range: 0 to 1

`chi2tail(`*df*`,`x`)`

Description: the reverse cumulative (upper tail or survivor) χ^2 distribution with *df* degrees of freedom; `1` if $x < 0$

`chi2tail(`*df*`,`x`)` $= 1 -$ `chi2(`*df*`,`x`)`

Domain *df*: 2e–10 to 2e+17 (may be nonintegral)

Domain x: $-$8e+307 to 8e+307; interesting domain is $x \geq 0$

Range: 0 to 1

`invchi2(`*df*`,`p`)`

Description: the inverse of `chi2()`: if `chi2(`*df*`,`x`)` $= p$, then `invchi2(`*df*`,`p`)` $= x$

Domain *df*: 2e–10 to 2e+17 (may be nonintegral)

Domain p: 0 to 1

Range: 0 to 8e+307

`invchi2tail(`*df*`,`p`)`

Description: the inverse of `chi2tail()`: if `chi2tail(`*df*`,`x`)` $= p$, then `invchi2tail(`*df*`,`p`)` $=$ x

Domain *df*: 2e–10 to 2e+17 (may be nonintegral)

Domain p: 0 to 1

Range: 0 to 8e+307

`nchi2den(`*df*`,`np`,`x`)`

Description: the probability density of the noncentral χ^2 distribution; `0` if $x < 0$

df denotes the degrees of freedom, np is the noncentrality parameter, and x is the value of χ^2.

`nchi2den(`*df*`,0,`x`)` $=$ `chi2den(`*df*`,`x`)`, but `chi2den()` is the preferred function to use for the central χ^2 distribution.

Domain *df*: 2e–10 to 1e+6 (may be nonintegral)

Domain np: 0 to 10,000

Domain x: $-$8e+307 to 8e+307

Range: 0 to 8e+307

`nchi2(`*df*`,`np`,`x`)`

Description: the cumulative noncentral χ^2 distribution; `0` if $x < 0$

The cumulative noncentral χ^2 distribution is defined as

$$\int_0^x \frac{e^{-t/2}\, e^{-np/2}}{2^{df/2}} \sum_{j=0}^{\infty} \frac{t^{\,df/2+j-1}\, np^j}{\Gamma(df/2+j)\, 2^{2j}\, j!}\, dt$$

where *df* denotes the degrees of freedom, np is the noncentrality parameter, and x is the value of χ^2.

`nchi2(`*df*`,0,`x`)` $=$ `chi2(`*df*`,`x`)`, but `chi2()` is the preferred function to use for the central χ^2 distribution.

Domain *df*: 2e–10 to 1e+6 (may be nonintegral)

Domain np: 0 to 10,000

Domain x: $-$8e+307 to 8e+307; interesting domain is $x \geq 0$

Range: 0 to 1

`nchi2tail(`df`,`np`,`x`)`

Description: the reverse cumulative (upper tail or survivor) noncentral χ^2 distribution; `1` if $x < 0$

df denotes the degrees of freedom, np is the noncentrality parameter, and x is the value of χ^2.

Domain df: 2e–10 to 1e+6 (may be nonintegral)

Domain np: 0 to 10,000

Domain x: $-$8e+307 to 8e+307

Range: 0 to 1

`invnchi2(`df`,`np`,`p`)`

Description: the inverse cumulative noncentral χ^2 distribution: if `nchi2(`df`,`np`,`x`)` $= p$, then `invnchi2(`df`,`np`,`p`)` $= x$

Domain df: 2e–10 to 1e+6 (may be nonintegral)

Domain np: 0 to 10,000

Domain p: 0 to 1

Range: 0 to 8e+307

`invnchi2tail(`df`,`np`,`p`)`

Description: the inverse reverse cumulative (upper tail or survivor) noncentral χ^2 distribution: if `nchi2tail(`df`,`np`,`x`)` $= p$, then `invnchi2tail(`df`,`np`,`p`)` $= x$

Domain df: 2e–10 to 1e+6 (may be nonintegral)

Domain np: 0 to 10,000

Domain p: 0 to 1

Range: 0 to 8e+307

`npnchi2(`df`,`x`,`p`)`

Description: the noncentrality parameter, np, for noncentral χ^2: if `nchi2(`df`,`np`,`x`)` $= p$, then `npnchi2(`df`,`x`,`p`)` $= np$

Domain df: 2e–10 to 1e+6 (may be nonintegral)

Domain x: 0 to 8e+307

Domain p: 0 to 1

Range: 0 to 10,000

Dunnett's multiple range distribution

`dunnettprob(`k`,`df`,`x`)`

Description: the cumulative multiple range distribution that is used in Dunnett's multiple-comparison method with k ranges and df degrees of freedom; `0` if $x < 0$

`dunnettprob()` is computed using an algorithm described in Miller (1981).

Domain k: 2 to 1e+6

Domain df: 2 to 1e+6

Domain x: $-$8e+307 to 8e+307; interesting domain is $x \geq 0$

Range: 0 to 1

`invdunnettprob(`k`,`df`,`p`)`

Description: the inverse cumulative multiple range distribution that is used in Dunnett's multiple-comparison method with k ranges and df degrees of freedom

If `dunnettprob(`k`,`df`,`x`)` $= p$, then `invdunnettprob(`k`,`df`,`p`)` $= x$.

`invdunnettprob()` is computed using an algorithm described in Miller (1981).

Domain k: 2 to 1e+6
Domain df: 2 to 1e+6
Domain p: 0 to 1 (right exclusive)
Range: 0 to 8e+307

Charles William Dunnett (1921–2007) was a Canadian statistician best known for his work on multiple-comparison procedures. He was born in Windsor, Ontario, and graduated in mathematics and physics from McMaster University. After naval service in World War II, Dunnett's career included further graduate work, teaching, and research at Toronto, Columbia, the New York State Maritime College, the Department of National Health and Welfare in Ottawa, Cornell, Lederle Laboratories, and Aberdeen before he became Professor of Clinical Epidemiology and Biostatistics at McMaster University in 1974. He was President and Gold Medalist of the Statistical Society of Canada. Throughout his career, Dunnett took a keen interest in computing. According to Google Scholar, his 1955 paper on comparing treatments with a control has been cited over 4,000 times.

Exponential distribution

`exponentialden(`b`,`x`)`

Description: the probability density function of the exponential distribution with scale b

The probability density function of the exponential distribution is

$$\frac{1}{b}\exp(-x/b)$$

where b is the scale and x is the value of an exponential variate.

Domain b: 1e–323 to 8e+307
Domain x: $-$8e+307 to 8e+307; interesting domain is $x \geq 0$
Range: 1e–323 to 8e+307

`exponential(`b`,`x`)`

Description: the cumulative exponential distribution with scale b

The cumulative distribution function of the exponential distribution is

$$1-\exp(-x/b)$$

for $x \geq 0$ and 0 for $x < 0$, where b is the scale and x is the value of an exponential variate.
The mean of the exponential distribution is b and its variance is b^2.

Domain b: 1e–323 to 8e+307
Domain x: $-$8e+307 to 8e+307; interesting domain is $x \geq 0$
Range: 0 to 1

`exponentialtail(`b`,`x`)`

Description: the reverse cumulative exponential distribution with scale b

The reverse cumulative distribution function of the exponential distribution is

$$\exp(-x/b)$$

where b is the scale and x is the value of an exponential variate.

Domain b: 1e–323 to 8e+307

Domain x: $-$8e+307 to 8e+307; interesting domain is $x \geq 0$

Range: 0 to 1

`invexponential(`b`,`p`)`

Description: the inverse cumulative exponential distribution with scale b: if `exponential(`b`,`x`)` $= p$, then `invexponential(`b`,`p`)` $= x$

Domain b: 1e–323 to 8e+307

Domain p: 0 to 1

Range: 1e–323 to 8e+307

`invexponentialtail(`b`,`p`)`

Description: the inverse reverse cumulative exponential distribution with scale b: if `exponentialtail(`b`,`x`)` $= p$, then `invexponentialtail(`b`,`p`)` $= x$

Domain b: 1e–323 to 8e+307

Domain p: 0 to 1

Range: 1e–323 to 8e+307

F and noncentral F distributions

`Fden(`df_1`,`df_2`,`f`)`

Description: the probability density function of the F distribution with df_1 numerator and df_2 denominator degrees of freedom; `0` if $f < 0$

The probability density function of the F distribution with df_1 numerator and df_2 denominator degrees of freedom is defined as

$$\texttt{Fden}(df_1,df_2,f) = \frac{\Gamma(\frac{df_1+df_2}{2})}{\Gamma(\frac{df_1}{2})\Gamma(\frac{df_2}{2})}\left(\frac{df_1}{df_2}\right)^{\frac{df_1}{2}} \cdot f^{\frac{df_1}{2}-1}\left(1+\frac{df_1}{df_2}f\right)^{-\frac{1}{2}(df_1+df_2)}$$

Domain df_1: 1e–323 to 8e+307 (may be nonintegral)

Domain df_2: 1e–323 to 8e+307 (may be nonintegral)

Domain f: $-$8e+307 to 8e+307; interesting domain is $f \geq 0$

Range: 0 to 8e+307

`F(`df_1`,`df_2`,`f`)`

Description: the cumulative F distribution with df_1 numerator and df_2 denominator degrees of freedom: `F(`df_1`,`df_2`,`f`)` $= \int_0^f$ `Fden(`df_1`,`df_2`,`t`)` dt; `0` if $f < 0$

Domain df_1: 2e–10 to 2e+17 (may be nonintegral)

Domain df_2: 2e–10 to 2e+17 (may be nonintegral)

Domain f: $-$8e+307 to 8e+307; interesting domain is $f \geq 0$

Range: 0 to 1

`Ftail(`df_1`,`df_2`,`f`)`

Description: the reverse cumulative (upper tail or survivor) F distribution with df_1 numerator and df_2 denominator degrees of freedom; `1` if $f < 0$

`Ftail(`df_1`,`df_2`,`f`)` $= 1 -$ `F(`df_1`,`df_2`,`f`)`.

Domain df_1: 2e–10 to 2e+17 (may be nonintegral)

Domain df_2: 2e–10 to 2e+17 (may be nonintegral)

Domain f: $-$8e+307 to 8e+307; interesting domain is $f \geq 0$

Range: 0 to 1

`invF(`df_1`,`df_2`,`p`)`

Description: the inverse cumulative F distribution: if `F(`df_1`,`df_2`,`f`)` $= p$, then `invF(`df_1`,`df_2`,`p`)` $= f$

Domain df_1: 2e–10 to 2e+17 (may be nonintegral)

Domain df_2: 2e–10 to 2e+17 (may be nonintegral)

Domain p: 0 to 1

Range: 0 to 8e+307

`invFtail(`df_1`,`df_2`,`p`)`

Description: the inverse reverse cumulative (upper tail or survivor) F distribution: if `Ftail(`df_1`,`df_2`,`f`)` $= p$, then `invFtail(`df_1`,`df_2`,`p`)` $= f$

Domain df_1: 2e–10 to 2e+17 (may be nonintegral)

Domain df_2: 2e–10 to 2e+17 (may be nonintegral)

Domain p: 0 to 1

Range: 0 to 8e+307

`nFden(`df_1`,`df_2`,`np`,`f`)`

Description: the probability density function of the noncentral F distribution with df_1 numerator and df_2 denominator degrees of freedom and noncentrality parameter np; `0` if $f < 0$

`nFden(`df_1`,`df_2`,0,`f`)` = `Fden(`df_1`,`df_2`,`f`)`, but `Fden()` is the preferred function to use for the central F distribution.

Also, if F follows the noncentral F distribution with df_1 and df_2 degrees of freedom and noncentrality parameter np, then

$$\frac{df_1 F}{df_2 + df_1 F}$$

follows a noncentral beta distribution with shape parameters $a = df_1/2$, $b = df_2/2$, and noncentrality parameter np, as given in `nbetaden()`. `nFden()` is computed based on this relationship.

Domain df_1: 1e–323 to 8e+307 (may be nonintegral)
Domain df_2: 1e–323 to 8e+307 (may be nonintegral)
Domain np: 0 to 1,000
Domain f: $-$8e+307 to 8e+307; interesting domain is $f \geq 0$
Range: 0 to 8e+307

`nF(`df_1`,`df_2`,`np`,`f`)`

Description: the cumulative noncentral F distribution with df_1 numerator and df_2 denominator degrees of freedom and noncentrality parameter np; `0` if $f < 0$

`nF(`df_1`,`df_2`,0,`f`)` = `F(`df_1`,`df_2`,`f`)`

`nF()` is computed using `nibeta()` based on the relationship between the noncentral beta and noncentral F distributions: `nF(`df_1`,`df_2`,`np`,`f`)` = `nibeta(`$df_1/2$`,`$df_2/2$`,`np`,`$df_1 \times f/\{(df_1 \times f) + df_2\}$`)`.

Domain df_1: 2e–10 to 1e+8
Domain df_2: 2e–10 to 1e+8
Domain np: 0 to 10,000
Domain f: $-$8e+307 to 8e+307
Range: 0 to 1

`nFtail(`df_1`,`df_2`,`np`,`f`)`

Description: the reverse cumulative (upper tail or survivor) noncentral F distribution with df_1 numerator and df_2 denominator degrees of freedom and noncentrality parameter np; `1` if $f < 0$

`nFtail()` is computed using `nibeta()` based on the relationship between the noncentral beta and F distributions. See Johnson, Kotz, and Balakrishnan (1995) for more details.

Domain df_1: 1e–323 to 8e+307 (may be nonintegral)
Domain df_2: 1e–323 to 8e+307 (may be nonintegral)
Domain np: 0 to 1,000
Domain f: $-$8e+307 to 8e+307; interesting domain is $f \geq 0$
Range: 0 to 1

`invnF(`df_1`,`df_2`,`np`,`p`)`

Description: the inverse cumulative noncentral F distribution: if
`nF(`df_1`,`df_2`,`np`,`f`)` $= p$, then `invnF(`df_1`,`df_2`,`np`,`p`)` $= f$

Domain df_1: 1e–6 to 1e+6 (may be nonintegral)
Domain df_2: 1e–6 to 1e+6 (may be nonintegral)
Domain np: 0 to 10,000
Domain p: 0 to 1
Range: 0 to 8e+307

`invnFtail(`df_1`,`df_2`,`np`,`p`)`

Description: the inverse reverse cumulative (upper tail or survivor) noncentral F distribution: if
`nFtail(`df_1`,`df_2`,`np`,`f`)` $= p$, then `invnFtail(`df_1`,`df_2`,`np`,`p`)` $= f$

Domain df_1: 1e–323 to 8e+307 (may be nonintegral)
Domain df_2: 1e–323 to 8e+307 (may be nonintegral)
Domain np: 0 to 1,000
Domain p: 0 to 1
Range: 0 to 8e+307

`npnF(`df_1`,`df_2`,`f`,`p`)`

Description: the noncentrality parameter, np, for the noncentral F: if
`nF(`df_1`,`df_2`,`np`,`f`)` $= p$, then `npnF(`df_1`,`df_2`,`f`,`p`)` $= np$

Domain df_1: 2e–10 to 1e+6 (may be nonintegral)
Domain df_2: 2e–10 to 1e+6 (may be nonintegral)
Domain f: 0 to 8e+307
Domain p: 0 to 1
Range: 0 to 1,000

Gamma distribution

`gammaden(`a`,`b`,`g`,`x`)`

Description: the probability density function of the gamma distribution; `0` if $x < g$

The probability density function of the gamma distribution is defined by

$$\frac{1}{\Gamma(a)b^a}(x-g)^{a-1}e^{-(x-g)/b}$$

where a is the shape parameter, b is the scale parameter, and g is the location parameter.

Domain a: 1e–323 to 8e+307
Domain b: 1e–323 to 8e+307
Domain g: $-$8e+307 to 8e+307
Domain x: $-$8e+307 to 8e+307; interesting domain is $x \geq g$
Range: 0 to 8e+307

gammap(a,x)

Description: the cumulative gamma distribution with shape parameter a; 0 if $x < 0$

The cumulative gamma distribution with shape parameter a is defined by

$$\frac{1}{\Gamma(a)} \int_0^x e^{-t} t^{a-1}\, dt$$

The cumulative Poisson (the probability of observing k or fewer events if the expected is x) can be evaluated as 1-gammap(k+1,x). The reverse cumulative (the probability of observing k or more events) can be evaluated as gammap(k,x). See Press et al. (2007, 259–266) for a more complete description and for suggested uses for this function.

gammap() is also known as the incomplete gamma function (ratio).

Probabilities for the three-parameter gamma distribution (see gammaden()) can be calculated by shifting and scaling x; that is, gammap(a,$(x-g)/b$).

Domain a: 1e–10 to 1e+17

Domain x: −8e+307 to 8e+307; interesting domain is $x \geq 0$

Range: 0 to 1

gammaptail(a,x)

Description: the reverse cumulative (upper tail or survivor) gamma distribution with shape parameter a; 1 if $x < 0$

The reverse cumulative (upper tail or survivor) gamma distribution with shape parameter a is defined by

$$\texttt{gammaptail}(a,x) = 1 - \texttt{gammap}(a,x) = \int_x^\infty \texttt{gammaden}(a,t)\, dt$$

gammaptail() is also known as the complement to the incomplete gamma function (ratio).

Domain a: 1e–10 to 1e+17

Domain x: −8e+307 to 8e+307; interesting domain is $x \geq 0$

Range: 0 to 1

invgammap(a,p)

Description: the inverse cumulative gamma distribution: if gammap(a,x) $= p$, then invgammap(a,p) $= x$

Domain a: 1e–10 to 1e+17

Domain p: 0 to 1

Range: 0 to 8e+307

`invgammaptail(`a`,`p`)`

Description: the inverse reverse cumulative (upper tail or survivor) gamma distribution: if `gammaptail(`a`,`x`)` $= p$, then `invgammaptail(`a`,`p`)` $= x$
Domain a: 1e–10 to 1e+17
Domain p: 0 to 1
Range: 0 to 8e+307

`dgammapda(`a`,`x`)`

Description: $\frac{\partial P(a,x)}{\partial a}$, where $P(a,x) =$ `gammap(`a`,`x`)`; 0 if $x < 0$
Domain a: 1e–7 to 1e+17
Domain x: $-$8e+307 to 8e+307; interesting domain is $x \geq 0$
Range: -16 to 0

`dgammapdada(`a`,`x`)`

Description: $\frac{\partial^2 P(a,x)}{\partial a^2}$, where $P(a,x) =$ `gammap(`a`,`x`)`; 0 if $x < 0$
Domain a: 1e–7 to 1e+17
Domain x: $-$8e+307 to 8e+307; interesting domain is $x \geq 0$
Range: -0.02 to 4.77e+5

`dgammapdadx(`a`,`x`)`

Description: $\frac{\partial^2 P(a,x)}{\partial a \partial x}$, where $P(a,x) =$ `gammap(`a`,`x`)`; 0 if $x < 0$
Domain a: 1e–7 to 1e+17
Domain x: $-$8e+307 to 8e+307; interesting domain is $x \geq 0$
Range: -0.04 to 8e+307

`dgammapdx(`a`,`x`)`

Description: $\frac{\partial P(a,x)}{\partial x}$, where $P(a,x) =$ `gammap(`a`,`x`)`; 0 if $x < 0$
Domain a: 1e–10 to 1e+17
Domain x: $-$8e+307 to 8e+307; interesting domain is $x \geq 0$
Range: 0 to 8e+307

`dgammapdxdx(`a`,`x`)`

Description: $\frac{\partial^2 P(a,x)}{\partial x^2}$, where $P(a,x) =$ `gammap(`a`,`x`)`; 0 if $x < 0$
Domain a: 1e–10 to 1e+17
Domain x: $-$8e+307 to 8e+307; interesting domain is $x \geq 0$
Range: 0 to 1e+40

`lnigammaden(`a`,`b`,`x`)`

Description: the natural logarithm of the inverse gamma density, where a is the shape parameter and b is the scale parameter
Domain a: 1e–300 to 1e+300
Domain b: 1e–300 to 1e+300
Domain x: $-$8e+307 to 8e+307
Range: 1e–300 to 8e+307

Hypergeometric distribution

`hypergeometricp(`N`,`K`,`n`,`k`)`

Description: the hypergeometric probability of k successes out of a sample of size n, from a population of size N containing K elements that have the attribute of interest

Success is obtaining an element with the attribute of interest.

Domain N: 2 to 1e+5
Domain K: 1 to $N-1$
Domain n: 1 to $N-1$
Domain k: `max(0,`$n-N+K$`)` to `min(`K`,`n`)`
Range: 0 to 1 (right exclusive)

`hypergeometric(`N`,`K`,`n`,`k`)`

Description: the cumulative probability of the hypergeometric distribution

N is the population size, K is the number of elements in the population that have the attribute of interest, and n is the sample size. Returned is the probability of observing k or fewer elements from a sample of size n that have the attribute of interest.

Domain N: 2 to 1e+5
Domain K: 1 to $N-1$
Domain n: 1 to $N-1$
Domain k: `max(0,`$n-N+K$`)` to `min(`K`,`n`)`
Range: 0 to 1

Inverse Gaussian distribution

`igaussianden(`m`,`a`,`x`)`

Description: the probability density of the inverse Gaussian distribution with mean m and shape parameter a; `0` if $x \le 0$

Domain m: 1e–323 to 8e+307
Domain a: 1e–323 to 8e+307
Domain x: $-$8e+307 to 8e+307
Range: 0 to 8e+307

`igaussian(`m`,`a`,`x`)`

Description: the cumulative inverse Gaussian distribution with mean m and shape parameter a; `0` if $x \le 0$

Domain m: 1e–323 to 8e+307
Domain a: 1e–323 to 8e+307
Domain x: $-$8e+307 to 8e+307
Range: 0 to 1

`igaussiantail(`m`,`a`,`x`)`

Description: the reverse cumulative (upper tail or survivor) inverse Gaussian distribution with mean m and shape parameter a; `1` if $x \le 0$

`igaussiantail(`m`,`a`,`x`)` $= 1 -$ `igaussian(`m`,`a`,`x`)`

Domain m: 1e–323 to 8e+307
Domain a: 1e–323 to 8e+307
Domain x: $-$8e+307 to 8e+307
Range: 0 to 1

`invigaussian(`m`,`a`,`p`)`
Description: the inverse of `igaussian()`: if `igaussian(`m`,`a`,`x`)` $= p$, then `invigaussian(`m`,`a`,`p`)` $= x$
Domain m: 1e–323 to 8e+307
Domain a: 1e–323 to 1e+8
Domain p: 0 to 1 (exclusive)
Range: 0 to 8e+307

`invigaussiantail(`m`,`a`,`p`)`
Description: the inverse of `igaussiantail()`: if `igaussiantail(`m`,`a`,`x`)` $= p$, then `invigaussiantail(`m`,`a`,`p`)` $= x$
Domain m: 1e–323 to 8e+307
Domain a: 1e–323 to 1e+8
Domain p: 0 to 1 (exclusive)
Range: 0 to 1

`lnigaussianden(`m`,`a`,`x`)`
Description: the natural logarithm of the inverse Gaussian density with mean m and shape parameter a
Domain m: 1e–323 to 8e+307
Domain a: 1e–323 to 8e+307
Domain x: 1e–323 to 8e+307
Range: $-$8e+307 to 8e+307

Laplace distribution

`laplaceden(`m`,`b`,`x`)`
Description: the probability density of the Laplace distribution with mean m and scale parameter b
Domain m: $-$8e+307 to 8e+307
Domain b: 1e–307 to 8e+307
Domain x: $-$8e+307 to 8e+307
Range: 0 to 8e+307

`laplace(`m`,`b`,`x`)`
Description: the cumulative Laplace distribution with mean m and scale parameter b
Domain m: $-$8e+307 to 8e+307
Domain b: 1e–307 to 8e+307
Domain x: $-$8e+307 to 8e+307
Range: 0 to 1

`laplacetail(`m`,`b`,`x`)`
Description: the reverse cumulative (upper tail or survivor) Laplace distribution with mean m and scale parameter b
`laplacetail(`m`,`b`,`x`)` $= 1 -$ `laplace(`m`,`b`,`x`)`
Domain m: $-$8e+307 to 8e+307
Domain b: 1e–307 to 8e+307
Domain x: $-$8e+307 to 8e+307
Range: 0 to 1

`invlaplace(`m`,`b`,`p`)`

Description: the inverse of `laplace()`: if `laplace(`m`,`b`,`x`)` $= p$, then `invlaplace(`m`,`b`,`p`)` $= x$

Domain m: $-8\text{e}+307$ to 8e+307

Domain b: 1e–307 to 8e+307

Domain p: 0 to 1 (exclusive)

Range: $-8\text{e}+307$ to 8e+307

`invlaplacetail(`m`,`b`,`p`)`

Description: the inverse of `laplacetail()`: if `laplacetail(`m`,`b`,`x`)` $= p$, then `invlaplacetail(`m`,`b`,`p`)` $= x$

Domain m: $-8\text{e}+307$ to 8e+307

Domain b: 1e–307 to 8e+307

Domain p: 0 to 1 (exclusive)

Range: $-8\text{e}+307$ to 8e+307

`lnlaplaceden(`m`,`b`,`x`)`

Description: the natural logarithm of the density of the Laplace distribution with mean m and scale parameter b

Domain m: $-8\text{e}+307$ to 8e+307

Domain b: 1e–307 to 8e+307

Domain x: $-8\text{e}+307$ to 8e+307

Range: $-8\text{e}+307$ to 707

Logistic distribution

`logisticden(`x`)`

Description: the density of the logistic distribution with mean 0 and standard deviation $\pi/\sqrt{3}$

`logisticden(`x`)` = `logisticden(1,`x`)` = `logisticden(0,1,`x`)`, where x is the value of a logistic random variable.

Domain x: $-8\text{e}+307$ to 8e+307

Range: 0 to 0.25

`logisticden(`s`,`x`)`

Description: the density of the logistic distribution with mean 0, scale s, and standard deviation $s\pi/\sqrt{3}$

`logisticden(`s`,`x`)` = `logisticden(0,`s`,`x`)`, where s is the scale and x is the value of a logistic random variable.

Domain s: 1e–323 to 8e+307

Domain x: $-8\text{e}+307$ to 8e+307

Range: 0 to 8e+307

`logisticden(`m`,`s`,`x`)`

Description: the density of the logistic distribution with mean m, scale s, and standard deviation $s\pi/\sqrt{3}$

The density of the logistic distribution is defined as

$$\frac{\exp\{-(x-m)/s\}}{s[1+\exp\{-(x-m)/s\}]^2}$$

where m is the mean, s is the scale, and x is the value of a logistic random variable.

Domain m: $-8\text{e}+307$ to 8e+307
Domain s: 1e–323 to 8e+307
Domain x: $-8\text{e}+307$ to 8e+307
Range: 0 to 8e+307

`logistic(`x`)`

Description: the cumulative logistic distribution with mean 0 and standard deviation $\pi/\sqrt{3}$

`logistic(`x`)` = `logistic(1,`x`)` = `logistic(0,1,`x`)`, where x is the value of a logistic random variable.

Domain x: $-8\text{e}+307$ to 8e+307
Range: 0 to 1

`logistic(`s`,`x`)`

Description: the cumulative logistic distribution with mean 0, scale s, and standard deviation $s\pi/\sqrt{3}$

`logistic(`s`, `x`)` = `logistic(0,`s`,`x`)`, where s is the scale and x is the value of a logistic random variable.

Domain s: 1e–323 to 8e+307
Domain x: $-8\text{e}+307$ to 8e+307
Range: 0 to 1

`logistic(`m`,`s`,`x`)`

Description: the cumulative logistic distribution with mean m, scale s, and standard deviation $s\pi/\sqrt{3}$

The cumulative logistic distribution is defined as

$$[1+\exp\{-(x-m)/s\}]^{-1}$$

where m is the mean, s is the scale, and x is the value of a logistic random variable.

Domain m: $-8\text{e}+307$ to 8e+307
Domain s: 1e–323 to 8e+307
Domain x: $-8\text{e}+307$ to 8e+307
Range: 0 to 1

`logistictail(`x`)`

Description: the reverse cumulative logistic distribution with mean 0 and standard deviation $\pi/\sqrt{3}$

`logistictail(`x`)` = `logistictail(1,`x`)` = `logistictail(0,1,`x`)`, where x is the value of a logistic random variable.

Domain x: $-8e+307$ to 8e+307
Range: 0 to 1

`logistictail(`s`,`x`)`

Description: the reverse cumulative logistic distribution with mean 0, scale s, and standard deviation $s\pi/\sqrt{3}$

`logistictail(`s`,`x`)` = `logistictail(0,`s`,`x`)`, where s is the scale and x is the value of a logistic random variable.

Domain s: 1e–323 to 8e+307
Domain x: $-8e+307$ to 8e+307
Range: 0 to 1

`logistictail(`m`,`s`,`x`)`

Description: the reverse cumulative logistic distribution with mean m, scale s, and standard deviation $s\pi/\sqrt{3}$

The reverse cumulative logistic distribution is defined as

$$[1 + \exp\{(x - m)/s\}]^{-1}$$

where m is the mean, s is the scale, and x is the value of a logistic random variable.

Domain m: $-8e+307$ to 8e+307
Domain s: 1e–323 to 8e+307
Domain x: $-8e+307$ to 8e+307
Range: 0 to 1

`invlogistic(`p`)`

Description: the inverse cumulative logistic distribution: if `logistic(`x`)` $= p$, then `invlogistic(`p`)` $= x$

Domain p: 0 to 1
Range: $-8e+307$ to 8e+307

`invlogistic(`s`,`p`)`

Description: the inverse cumulative logistic distribution: if `logistic(`s`,`x`)` $= p$, then `invlogistic(`s`,`p`)` $= x$

Domain s: 1e–323 to 8e+307
Domain p: 0 to 1
Range: $-8e+307$ to 8e+307

`invlogistic(`m`,`s`,`p`)`

Description: the inverse cumulative logistic distribution: if `logistic(`m`,`s`,`x`)` $= p$, then `invlogistic(`m`,`s`,`p`)` $= x$

Domain m: $-8\text{e}{+}307$ to 8e+307
Domain s: 1e–323 to 8e+307
Domain p: 0 to 1
Range: $-8\text{e}{+}307$ to 8e+307

`invlogistictail(`p`)`

Description: the inverse reverse cumulative logistic distribution: if `logistictail(`x`)` $= p$, then `invlogistictail(`p`)` $= x$

Domain p: 0 to 1
Range: $-8\text{e}{+}307$ to 8e+307

`invlogistictail(`s`,`p`)`

Description: the inverse reverse cumulative logistic distribution: if `logistictail(`s`,`x`)` $= p$, then `invlogistictail(`s`,`p`)` $= x$

Domain s: 1e–323 to 8e+307
Domain p: 0 to 1
Range: $-8\text{e}{+}307$ to 8e+307

`invlogistictail(`m`,`s`,`p`)`

Description: the inverse reverse cumulative logistic distribution: if `logistictail(`m`,`s`,`x`)` $= p$, then `invlogistictail(`m`,`s`,`p`)` $= x$

Domain m: $-8\text{e}{+}307$ to 8e+307
Domain s: 1e–323 to 8e+307
Domain p: 0 to 1
Range: $-8\text{e}{+}307$ to 8e+307

Negative binomial distribution

`nbinomialp(`n`,`k`,`p`)`

Description: the negative binomial probability

When n is an integer, `nbinomialp()` returns the probability of observing exactly `floor(`k`)` failures before the nth success when the probability of a success on one trial is p.

Domain n: 1e–10 to 1e+6 (can be nonintegral)
Domain k: 0 to 1e+10
Domain p: 0 to 1 (left exclusive)
Range: 0 to 1

`nbinomial(`n`,`k`,`p`)`

Description: the cumulative probability of the negative binomial distribution

n can be nonintegral. When n is an integer, `nbinomial()` returns the probability of observing k or fewer failures before the nth success, when the probability of a success on one trial is p.

The negative binomial distribution function is evaluated using `ibeta()`.

Domain n: 1e–10 to 1e+17 (can be nonintegral)
Domain k: 0 to $2^{53} - 1$
Domain p: 0 to 1 (left exclusive)
Range: 0 to 1

`nbinomialtail(`n`,`k`,`p`)`

Description: the reverse cumulative probability of the negative binomial distribution

When n is an integer, `nbinomialtail()` returns the probability of observing k or more failures before the nth success, when the probability of a success on one trial is p.

The reverse negative binomial distribution function is evaluated using `ibetatail()`.

Domain n: 1e–10 to 1e+17 (can be nonintegral)
Domain k: 0 to $2^{53} - 1$
Domain p: 0 to 1 (left exclusive)
Range: 0 to 1

`invnbinomial(`n`,`k`,`q`)`

Description: the value of the negative binomial parameter, p, such that $q =$ `nbinomial(`n`,`k`,`p`)`

`invnbinomial()` is evaluated using `invibeta()`.

Domain n: 1e–10 to 1e+17 (can be nonintegral)
Domain k: 0 to $2^{53} - 1$
Domain q: 0 to 1 (exclusive)
Range: 0 to 1

`invnbinomialtail(`n`,`k`,`q`)`

Description: the value of the negative binomial parameter, p, such that
$q =$ `nbinomialtail(`n`,`k`,`p`)`

`invnbinomialtail()` is evaluated using `invibetatail()`.

Domain n: 1e–10 to 1e+17 (can be nonintegral)
Domain k: 1 to $2^{53} - 1$
Domain q: 0 to 1 (exclusive)
Range: 0 to 1 (exclusive)

Normal (Gaussian), binormal, and multivariate normal distributions

`normalden(`z`)`

Description: the standard normal density, $N(0, 1)$
Domain: $-8\text{e}+307$ to 8e+307
Range: 0 to 0.39894 . . .

`normalden(`x`,`σ`)`

Description: the normal density with mean 0 and standard deviation σ

`normalden(`x`,1)` $=$ `normalden(`x`)` and
`normalden(`x`,`σ`)` $=$ `normalden(`x/σ`)`$/\sigma$.

Domain x: $-$8e+307 to 8e+307
Domain σ: 1e–308 to 8e+307
Range: 0 to 8e+307

`normalden(`x`,`μ`,`σ`)`

Description: the normal density with mean μ and standard deviation σ, $N(\mu, \sigma^2)$

`normalden(`x`,0,`s`)` $=$ `normalden(`x`,`s`)` and
`normalden(`x`,`μ`,`σ`)` $=$ `normalden((`$x-\mu$`)/`σ`)`$/\sigma$. In general,

$$\texttt{normalden}(z,\mu,\sigma) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{1}{2}\left\{\frac{(z-\mu)}{\sigma}\right\}^2}$$

Domain x: $-$8e+307 to 8e+307
Domain μ: $-$8e+307 to 8e+307
Domain σ: 1e–308 to 8e+307
Range: 0 to 8e+307

`normal(`z`)`

Description: the cumulative standard normal distribution

`normal(`z`)` $= \int_{-\infty}^{z} \frac{1}{\sqrt{2\pi}} e^{-x^2/2} dx$

Domain: $-$8e+307 to 8e+307
Range: 0 to 1

`invnormal(`p`)`

Description: the inverse cumulative standard normal distribution: if `normal(`z`)` $= p$, then `invnormal(`p`)` $= z$

Domain: 1e–323 to $1 - 2^{-53}$
Range: $-$38.449394 to 8.2095362

`lnnormalden(`z`)`

Description: the natural logarithm of the standard normal density, $N(0, 1)$

Domain: $-$1e+154 to 1e+154
Range: $-$5e+307 to $-$0.91893853 $=$ `lnnormalden(0)`

`lnnormalden(`x`,`σ`)`

Description: the natural logarithm of the normal density with mean 0 and standard deviation σ

`lnnormalden(`x`, 1)` $=$ `lnnormalden(`x`)` and
`lnnormalden(`x`,`σ`)` $=$ `lnnormalden(`x/σ`)` $-$ $\ln(\sigma)$.

Domain x: $-$8e+307 to 8e+307
Domain σ: 1e–323 to 8e+307
Range: $-$5e+307 to 742.82799

`lnnormalden(`x`,`μ`,`σ`)`

Description: the natural logarithm of the normal density with mean μ and standard deviation σ, $N(\mu, \sigma^2)$

`lnnormalden(`x`,0,`s`)` $=$ `lnnormalden(`x`,`s`)` and `lnnormalden(`x`,`μ`,`σ`)` $=$ `lnnormalden((`$x-\mu$`)/`σ`)` $-\ \ln(\sigma)$. In general,

$$\texttt{lnnormalden(}z\texttt{,}\mu\texttt{,}\sigma\texttt{)} = \ln\left[\frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{1}{2}\left\{\frac{(z-\mu)}{\sigma}\right\}^2}\right]$$

Domain x: $-$8e+307 to 8e+307
Domain μ: $-$8e+307 to 8e+307
Domain σ: 1e–323 to 8e+307
Range: 1e–323 to 8e+307

`lnnormal(`z`)`

Description: the natural logarithm of the cumulative standard normal distribution

$$\texttt{lnnormal(}z\texttt{)} = \ln\left(\int_{-\infty}^{z} \frac{1}{\sqrt{2\pi}} e^{-x^2/2} dx\right)$$

Domain: $-$1e+99 to 8e+307
Range: $-$5e+197 to 0

`binormal(`h`,`k`,`ρ`)`

Description: the joint cumulative distribution $\Phi(h, k, \rho)$ of bivariate normal with correlation ρ

Cumulative over $(-\infty, h\,] \times (-\infty, k\,]$:

$$\Phi(h, k, \rho) = \frac{1}{2\pi\sqrt{1-\rho^2}} \int_{-\infty}^{h} \int_{-\infty}^{k} \exp\left\{-\frac{1}{2(1-\rho^2)}\left(x_1^2 - 2\rho x_1 x_2 + x_2^2\right)\right\} dx_1\, dx_2$$

Domain h: $-$8e+307 to 8e+307
Domain k: $-$8e+307 to 8e+307
Domain ρ: $-$1 to 1
Range: 0 to 1

`lnmvnormalden(`M`,`V`,`X`)`

Description: the natural logarithm of the multivariate normal density

M is the mean vector, V is the covariance matrix, and X is the random vector.

Domain M: $1 \times n$ and $n \times 1$ vectors
Domain V: $n \times n$, positive-definite, symmetric matrices
Domain X: $1 \times n$ and $n \times 1$ vectors
Range: $-$8e+307 to 8e+307

Poisson distribution

`poissonp(`m`,`k`)`

Description: the probability of observing `floor(`k`)` outcomes that are distributed as Poisson with mean m

The Poisson probability function is evaluated using `gammaden()`.

Domain m: 1e–10 to 1e+8
Domain k: 0 to 1e+9
Range: 0 to 1

`poisson(`m`,`k`)`

Description: the probability of observing `floor(`k`)` or fewer outcomes that are distributed as Poisson with mean m

The Poisson distribution function is evaluated using `gammaptail()`.

Domain m: 1e–10 to $2^{53}-1$
Domain k: 0 to $2^{53}-1$
Range: 0 to 1

`poissontail(`m`,`k`)`

Description: the probability of observing `floor(`k`)` or more outcomes that are distributed as Poisson with mean m

The reverse cumulative Poisson distribution function is evaluated using `gammap()`.

Domain m: 1e–10 to $2^{53}-1$
Domain k: 0 to $2^{53}-1$
Range: 0 to 1

`invpoisson(`k`,`p`)`

Description: the Poisson mean such that the cumulative Poisson distribution evaluated at k is p: if `poisson(`m`,`k`)` $= p$, then `invpoisson(`k`,`p`)` $= m$

The inverse Poisson distribution function is evaluated using `invgammaptail()`.

Domain k: 0 to $2^{53}-1$
Domain p: 0 to 1 (exclusive)
Range: 1.110e–16 to 2^{53}

`invpoissontail(`k`,`q`)`

Description: the Poisson mean such that the reverse cumulative Poisson distribution evaluated at k is q: if `poissontail(`m`,`k`)` $= q$, then `invpoissontail(`k`,`q`)` $= m$

The inverse of the reverse cumulative Poisson distribution function is evaluated using `invgammap()`.

Domain k: 0 to $2^{53}-1$
Domain q: 0 to 1 (exclusive)
Range: 0 to 2^{53} (left exclusive)

Student's t and noncentral Student's t distributions

`tden(`df`,`t`)`

Description: the probability density function of Student's t distribution

$$\texttt{tden}(df,t) = \frac{\Gamma\{(df+1)/2\}}{\sqrt{\pi df}\,\Gamma(df/2)} \cdot \left(1 + t^2/df\right)^{-(df+1)/2}$$

Domain df: 1e–323 to 8e+307(may be nonintegral)
Domain t: −8e+307 to 8e+307
Range: 0 to 0.39894 ...

`t(`df`,`t`)`

Description: the cumulative Student's t distribution with df degrees of freedom
Domain df: 2e–10 to 2e+17 (may be nonintegral)
Domain t; −8e+307 to 8e+307
Range: 0 to 1

`ttail(`df`,`t`)`

Description: the reverse cumulative (upper tail or survivor) Student's t distribution; the probability $T > t$

$$\texttt{ttail}(df,t) = \int_t^{\infty} \frac{\Gamma\{(df+1)/2\}}{\sqrt{\pi df}\,\Gamma(df/2)} \cdot \left(1 + x^2/df\right)^{-(df+1)/2} \, dx$$

Domain df: 2e–10 to 2e+17 (may be nonintegral)
Domain t: −8e+307 to 8e+307
Range: 0 to 1

`invt(`df`,`p`)`

Description: the inverse cumulative Student's t distribution: if `t(`df`,`t`)` $= p$, then `invt(`df`,`p`)` $= t$
Domain df: 2e–10 to 2e+17 (may be nonintegral)
Domain p: 0 to 1
Range: −8e+307 to 8e+307

`invttail(`df`,`p`)`

Description: the inverse reverse cumulative (upper tail or survivor) Student's t distribution: if `ttail(`df`,`t`)` $= p$, then `invttail(`df`,`p`)` $= t$
Domain df: 2e–10 to 2e+17 (may be nonintegral)
Domain p: 0 to 1
Range: −8e+307 to 8e+307

`invnt(`df`,`np`,`p`)`

Description: the inverse cumulative noncentral Student's t distribution: if `nt(`df`,`np`,`t`)` $= p$, then `invnt(`df`,`np`,`p`)` $= t$
Domain df: 1 to 1e+6 (may be nonintegral)
Domain np: −1,000 to 1,000
Domain p: 0 to 1
Range: −8e+307 to 8e+307

`invnttail(`df`,`np`,`p`)`

Description: the inverse reverse cumulative (upper tail or survivor) noncentral Student's t distribution: if `nttail(`df`,`np`,`t`)` $= p$, then `invnttail(`df`,`np`,`p`)` $= t$

Domain df: 1 to 1e+6 (may be nonintegral)

Domain np: $-1{,}000$ to 1,000

Domain p: 0 to 1

Range: $-8\text{e+}10$ to 8e+10

`ntden(`df`,`np`,`t`)`

Description: the probability density function of the noncentral Student's t distribution with df degrees of freedom and noncentrality parameter np

Domain df: 1e–100 to 1e+10 (may be nonintegral)

Domain np: $-1{,}000$ to 1,000

Domain t: $-8\text{e+}307$ to 8e+307

Range: 0 to 0.39894 ...

`nt(`df`,`np`,`t`)`

Description: the cumulative noncentral Student's t distribution with df degrees of freedom and noncentrality parameter np

`nt(`df`,0,`t`)` $=$ `t(`df`,`t`)`.

Domain df: 1e–100 to 1e+10 (may be nonintegral)

Domain np: $-1{,}000$ to 1,000

Domain t: $-8\text{e+}307$ to 8e+307

Range: 0 to 1

`nttail(`df`,`np`,`t`)`

Description: the reverse cumulative (upper tail or survivor) noncentral Student's t distribution with df degrees of freedom and noncentrality parameter np

Domain df: 1e–100 to 1e+10 (may be nonintegral)

Domain np: $-1{,}000$ to 1,000

Domain t: $-8\text{e+}307$ to 8e+307

Range: 0 to 1

`npnt(`df`,`t`,`p`)`

Description: the noncentrality parameter, np, for the noncentral Student's t distribution: if `nt(`df`,`np`,`t`)` $= p$, then `npnt(`df`,`t`,`p`)` $= np$

Domain df: 1e–100 to 1e+8 (may be nonintegral)

Domain t: $-8\text{e+}307$ to 8e+307

Domain p: 0 to 1

Range: $-1{,}000$ to 1,000

Tukey's Studentized range distribution

`tukeyprob(`k`,`df`,`x`)`

Description: the cumulative Tukey's Studentized range distribution with k ranges and df degrees of freedom; `0` if $x < 0$

If df is a missing value, then the normal distribution is used instead of Student's t.

`tukeyprob()` is computed using an algorithm described in Miller (1981).

Domain k: 2 to 1e+6
Domain df: 2 to 1e+6
Domain x: −8e+307 to 8e+307
Range: 0 to 1

`invtukeyprob(`k`,`df`,`p`)`

Description: the inverse cumulative Tukey's Studentized range distribution with k ranges and df degrees of freedom

If df is a missing value, then the normal distribution is used instead of Student's t. If `tukeyprob(`k`,`df`,`x`)` $= p$, then `invtukeyprob(`k`,`df`,`p`)` $= x$.

`invtukeyprob()` is computed using an algorithm described in Miller (1981).

Domain k: 2 to 1e+6
Domain df: 2 to 1e+6
Domain p: 0 to 1
Range: 0 to 8e+307

Weibull distribution

`weibullden(`a`,`b`,`x`)`

Description: the probability density function of the Weibull distribution with shape a and scale b

`weibullden(`a`,`b`,`x`)` = `weibullden(`a`, `b`, 0, `x`)`, where a is the shape, b is the scale, and x is the value of Weibull random variable.

Domain a: 1e–323 to 8e+307
Domain b: 1e–323 to 8e+307
Domain x: 1e–323 to 8e+307
Range: 0 to 8e+307

`weibullden(`a`,`b`,`g`,`x`)`

Description: the probability density function of the Weibull distribution with shape a, scale b, and location g

The probability density function of the generalized Weibull distribution is defined as

$$\frac{a}{b}\left(\frac{x-g}{b}\right)^{a-1}\exp\left\{-\left(\frac{x-g}{b}\right)^{a}\right\}$$

for $x \geq g$ and 0 for $x < g$, where a is the shape, b is the scale, g is the location parameter, and x is the value of a generalized Weibull random variable.

Domain a: 1e–323 to 8e+307
Domain b: 1e–323 to 8e+307
Domain g: −8e+307 to 8e+307
Domain x: −8e+307 to 8e+307; interesting domain is $x \geq g$
Range: 0 to 8e+307

`weibull(`a`,`b`,`x`)`

Description: the cumulative Weibull distribution with shape a and scale b

`weibull(`a`,`b`,`x`)` = `weibull(`a`, `b`, 0, `x`)`, where a is the shape, b is the scale, and x is the value of Weibull random variable.

Domain a: 1e–323 to 8e+307
Domain b: 1e–323 to 8e+307
Domain x: 1e–323 to 8e+307
Range: 0 to 1

`weibull(`a`,`b`,`g`,`x`)`

Description: the cumulative Weibull distribution with shape a, scale b, and location g

The cumulative Weibull distribution is defined as

$$1-\exp\left[-\left(\frac{x-g}{b}\right)^{a}\right]$$

for $x \geq g$ and 0 for $x < g$, where a is the shape, b is the scale, g is the location parameter, and x is the value of a Weibull random variable.
The mean of the Weibull distribution is $g + b\Gamma\{(a+1)/a\}$ and its variance is $b^2\left(\Gamma\{(a+2)/a\} - [\Gamma\{(a+1)/a\}]^2\right)$ where $\Gamma()$ is the gamma function described in `lngamma()`.

Domain a: 1e–323 to 8e+307
Domain b: 1e–323 to 8e+307
Domain g: −8e+307 to 8e+307
Domain x: −8e+307 to 8e+307; interesting domain is $x \geq g$
Range: 0 to 1

`weibulltail(`a`,`b`,`x`)`

Description: the reverse cumulative Weibull distribution with shape a and scale b

`weibulltail(`a`,`b`,`x`)` = `weibulltail(`a`,`b`,0,`x`)`, where a is the shape, b is the scale, and x is the value of a Weibull random variable.

Domain a: 1e–323 to 8e+307
Domain b: 1e–323 to 8e+307
Domain x: 1e–323 to 8e+307
Range: 0 to 1

`weibulltail(`a`,`b`,`g`,`x`)`

Description: the reverse cumulative Weibull distribution with shape a, scale b, and location g

The reverse cumulative Weibull distribution is defined as

$$\exp\left\{-\left(\frac{x-g}{b}\right)^a\right\}$$

for $x \geq g$ and 0 if $x < g$, where a is the shape, b is the scale, g is the location parameter, and x is the value of a generalized Weibull random variable.

Domain a: 1e–323 to 8e+307
Domain b: 1e–323 to 8e+307
Domain g: $-$8e+307 to 8e+307
Domain x: $-$8e+307 to 8e+307; interesting domain is $x \geq g$
Range: 0 to 1

`invweibull(`a`,`b`,`p`)`

Description: the inverse cumulative Weibull distribution with shape a and scale b: if `weibull(`a`,`b`,`x`)` $= p$, then `invweibull(`a`,`b`,`p`)` $= x$

Domain a: 1e–323 to 8e+307
Domain b: 1e–323 to 8e+307
Domain p: 0 to 1
Range: 1e–323 to 8e+307

`invweibull(`a`,`b`,`g`,`p`)`

Description: the inverse cumulative Weibull distribution with shape a, scale b, and location g: if `weibull(`a`,`b`,`g`,`x`)` $= p$, then
`invweibull(`a`,`b`,`g`,`p`)` $= x$

Domain a: 1e–323 to 8e+307
Domain b: 1e–323 to 8e+307
Domain g: $-$8e+307 to 8e+307
Domain p: 0 to 1
Range: g + `c(epsdouble)` to 8e+307

`invweibulltail(`a`,`b`,`p`)`

Description: the inverse reverse cumulative Weibull distribution with shape a and scale b: if `weibulltail(`a`,`b`,`x`)` $= p$, then
`invweibulltail(`a`,`b`,`p`)` $= x$

Domain a: 1e–323 to 8e+307

Domain b: 1e–323 to 8e+307

Domain p: 0 to 1

Range: 1e–323 to 8e+307

`invweibulltail(`a`,`b`,`g`,`p`)`

Description: the inverse reverse cumulative Weibull distribution with shape a, scale b, and location g: if `weibulltail(`a`,`b`,`g`,`x`)` $= p$, then
`invweibulltail(`a`,`b`,`g`,`p`)` $= x$

Domain a: 1e–323 to 8e+307

Domain b: 1e–323 to 8e+307

Domain g: $-$8e+307 to 8e+307

Domain p: 0 to 1

Range: $g +$ `c(epsdouble)` to 8e+307

Weibull (proportional hazards) distribution

`weibullphden(`a`,`b`,`x`)`

Description: the probability density function of the Weibull (proportional hazards) distribution with shape a and scale b

`weibullphden(`a`,`b`,`x`)` = `weibullphden(`a`, `b`, 0, `x`)`, where a is the shape, b is the scale, and x is the value of Weibull (proportional hazards) random variable.

Domain a: 1e–323 to 8e+307

Domain b: 1e–323 to 8e+307

Domain x: 1e–323 to 8e+307

Range: 0 to 8e+307

`weibullphden(`a`,`b`,`g`,`x`)`

Description: the probability density function of the Weibull (proportional hazards) distribution with shape a, scale b, and location g

The probability density function of the Weibull (proportional hazards) distribution is defined as

$$ba(x-g)^{a-1}\exp\left\{-b(x-g)^a\right\}$$

for $x \geq g$ and 0 for $x < g$, where a is the shape, b is the scale, g is the location parameter, and x is the value of a Weibull (proportional hazards) random variable.

Domain a: 1e–323 to 8e+307

Domain b: 1e–323 to 8e+307

Domain g: $-$8e+307 to 8e+307

Domain x: $-$8e+307 to 8e+307; interesting domain is $x \geq g$

Range: 0 to 8e+307

`weibullph(`a`,`b`,`x`)`

Description: the cumulative Weibull (proportional hazards) distribution with shape a and scale b

`weibullph(`a`,`b`,`x`)` = `weibullph(`a`, `b`, 0, `x`)`, where a is the shape, b is the scale, and x is the value of Weibull random variable.

Domain a: 1e–323 to 8e+307
Domain b: 1e–323 to 8e+307
Domain x: 1e–323 to 8e+307
Range: 0 to 1

`weibullph(`a`,`b`,`g`,`x`)`

Description: the cumulative Weibull (proportional hazards) distribution with shape a, scale b, and location g

The cumulative Weibull (proportional hazards) distribution is defined as

$$1 - \exp\left\{-b(x-g)^a\right\}$$

for $x \geq g$ and 0 if $x < g$, where a is the shape, b is the scale, g is the location parameter, and x is the value of a Weibull (proportional hazards) random variable. The mean of the Weibull (proportional hazards) distribution is

$$g + b^{-\frac{1}{a}}\Gamma\{(a+1)/a)\}$$

and its variance is

$$b^{-\frac{2}{a}}\left(\Gamma\{(a+2)/a\} - [\Gamma\{(a+1)/a\}]^2\right)$$

where $\Gamma()$ is the gamma function described in `lngamma(`x`)` .

Domain a: 1e–323 to 8e+307
Domain b: 1e–323 to 8e+307
Domain g: $-$8e+307 to 8e+307
Domain x: $-$8e+307 to 8e+307; interesting domain is $x \geq g$
Range: 0 to 1

`weibullphtail(`a`,`b`,`x`)`

Description: the reverse cumulative Weibull (proportional hazards) distribution with shape a and scale b

`weibullphtail(`a`,`b`,`x`)` = `weibullphtail(`a`,`b`,0,`x`)`, where a is the shape, b is the scale, and x is the value of a Weibull (proportional hazards) random variable.

Domain a: 1e–323 to 8e+307
Domain b: 1e–323 to 8e+307
Domain x: 1e–323 to 8e+307
Range: 0 to 1

`weibullphtail(`a`,`b`,`g`,`x`)`

Description: the reverse cumulative Weibull (proportional hazards) distribution with shape a, scale b, and location g

The reverse cumulative Weibull (proportional hazards) distribution is defined as

$$\exp\left\{-b(x-g)^a\right\}$$

for $x \geq g$ and 0 of $x < g$, where a is the shape, b is the scale, g is the location parameter, and x is the value of a Weibull (proportional hazards) random variable.

Domain a: 1e–323 to 8e+307
Domain b: 1e–323 to 8e+307
Domain g: −8e+307 to 8e+307
Domain x: −8e+307 to 8e+307; interesting domain is $x \geq g$
Range: 0 to 1

`invweibullph(`a`,`b`,`p`)`

Description: the inverse cumulative Weibull (proportional hazards) distribution with shape a and scale b: if `weibullph(`a`,`b`,`x`)` $= p$, then `invweibullph(`a`,`b`,`p`)` $= x$
Domain a: 1e–323 to 8e+307
Domain b: 1e–323 to 8e+307
Domain p: 0 to 1
Range: 1e–323 to 8e+307

`invweibullph(`a`,`b`,`g`,`p`)`

Description: the inverse cumulative Weibull (proportional hazards) distribution with shape a, scale b, and location g: if `weibullph(`a`,`b`,`g`,`x`)` $= p$, then `invweibullph(`a`,`b`,`g`,`p`)` $= x$
Domain a: 1e–323 to 8e+307
Domain b: 1e–323 to 8e+307
Domain g: −8e+307 to 8e+307
Domain p: 0 to 1
Range: $g +$ `c(epsdouble)` to 8e+307

`invweibullphtail(`a`,`b`,`p`)`

Description: the inverse reverse cumulative Weibull (proportional hazards) distribution with shape a and scale b: if `weibullphtail(`a`,`b`,`x`)` $= p$, then `invweibullphtail(`a`,`b`,`p`)` $= x$
Domain a: 1e–323 to 8e+307
Domain b: 1e–323 to 8e+307
Domain p: 0 to 1
Range: 1e–323 to 8e+307

`invweibullphtail(`a`,`b`,`g`,`p`)`

Description: the inverse reverse cumulative Weibull (proportional hazards) distribution with shape a, scale b, and location g: if `weibullphtail(`a`,`b`,`g`,`x`)` $= p$, then `invweibullphtail(`a`,`b`,`g`,`p`)` $= x$

Domain a: 1e–323 to 8e+307

Domain b: 1e–323 to 8e+307

Domain g: $-$8e+307 to 8e+307

Domain p: 0 to 1

Range: $g +$ `c(epsdouble)` to 8e+307

Wishart distribution

`lnwishartden(`df`,`V`,`X`)`

Description: the natural logarithm of the density of the Wishart distribution; missing if $df \leq n-1$

df denotes the degrees of freedom, V is the scale matrix, and X is the Wishart random matrix.

Domain df: 1 to 1e+100 (may be nonintegral)

Domain V: $n \times n$, positive-definite, symmetric matrices

Domain X: $n \times n$, positive-definite, symmetric matrices

Range: $-$8e+307 to 8e+307

`lniwishartden(`df`,`V`,`X`)`

Description: the natural logarithm of the density of the inverse Wishart distribution; missing if $df \leq n-1$

df denotes the degrees of freedom, V is the scale matrix, and X is the inverse Wishart random matrix.

Domain df: 1 to 1e+100 (may be nonintegral)

Domain V: $n \times n$, positive-definite, symmetric matrices

Domain X: $n \times n$, positive-definite, symmetric matrices

Range: $-$8e+307 to 8e+307

John Wishart (1898–1956) was born in Montrose, Scotland. He obtained a degree in mathematics and physics from the University of Edinburgh. He learned mathematics from E. T. Whittaker, upon whose recommendation he became Karl Pearson's research assistant. During his apprenticeship, he worked on approximations to the incomplete beta function and published multiple papers on this topic. He is best known for deriving the generalized product moment distribution, which was consequently named the Wishart distribution. This distribution is a critical component in the calculation of covariance matrices and Bayesian statistics.

Wishart served in both world wars, fighting with the Black Watch regiment in the first and working for the Intelligence Corps in the second. Upon his return from World War II, he resumed his involvement with the Royal Statistical Society, becoming chairman of the Research Section in 1945. A few years later, he also served as Associate Editor for the journal *Biometrika*.

He taught courses in statistics and agriculture at Cambridge and became the Head of the Statistical Laboratory. He published multiple papers applying statistical methods to agricultural research and was involved with the United Nations Food and Agriculture Organization. He was in Mexico to establish an agricultural research center on behalf of this organization when he died.

References

Dunnett, C. W. 1955. A multiple comparison for comparing several treatments with a control. *Journal of the American Statistical Association* 50: 1096–1121.

Johnson, N. L., S. Kotz, and N. Balakrishnan. 1995. *Continuous Univariate Distributions, Vol. 2*. 2nd ed. New York: Wiley.

Miller, R. G., Jr. 1981. *Simultaneous Statistical Inference*. 2nd ed. New York: Springer.

Moore, R. J. 1982. Algorithm AS 187: Derivatives of the incomplete gamma integral. *Applied Statistics* 31: 330–335.

Posten, H. O. 1993. An effective algorithm for the noncentral beta distribution function. *American Statistician* 47: 129–131.

Press, W. H., S. A. Teukolsky, W. T. Vetterling, and B. P. Flannery. 2007. *Numerical Recipes: The Art of Scientific Computing*. 3rd ed. New York: Cambridge University Press.

Tamhane, A. C. 2008. Eulogy to Charles Dunnett. *Biometrical Journal* 50: 636–637.

Also see

[FN] **Functions by category**

[D] **egen** — Extensions to generate

[D] **generate** — Create or change contents of variable

[M-4] **Statistical** — Statistical functions

[U] **13.3 Functions**