Package 'boostmath'

July 31, 2025

Title 'R' Bindings for the 'Boost' Math Functions

Version 1.0.2

Description 'R' bindings for the various functions and statistical distributions provided by the 'Boost' Math library <https://www.boost.org/doc/libs/latest/libs/math/doc/html/index.html>.

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URL https://github.com/andrjohns/boostmath, https://www.boost.org/doc/libs/latest/libs/math/doc/html/index.html

BugReports https://github.com/andrjohns/boostmath/issues

Encoding UTF-8

RoxygenNote 7.3.2

Depends R (>= 3.0.2)

LinkingTo cpp11, BH (>= 1.87.0)

NeedsCompilation yes

Suggests knitr, rmarkdown, tinytest

VignetteBuilder knitr

Author Andrew R. Johnson [aut, cre] (ORCID: <https://orcid.org/0000-0001-7000-8065>)

Maintainer Andrew R. Johnson <andrew.johnson@arjohnsonau.com>

Repository CRAN

Date/Publication 2025-07-31 14:30:02 UTC

Contents

`airy_functions` *Airy Functions*

Description

Functions to compute the Airy functions Ai and Bi, their derivatives, and their zeros.

Usage

```
airy_ai(x)

airy_bi(x)

airy_ai_prime(x)

airy_bi_prime(x)

airy_ai_zero(m = NULL, start_index = NULL, number_of_zeros = NULL)

airy_bi_zero(m = NULL, start_index = NULL, number_of_zeros = NULL)
```

Arguments

`x`	Input numeric value
`m`	The index of the zero to find (1-based).
`start_index`	The starting index for the zeros (1-based).
`number_of_zeros`	The number of zeros to find.

Value

Single numeric value for the Airy functions and their derivatives, or a vector of length `number_of_zeros` for the multiple zero functions.

See Also

Boost Documentation for more details on the mathematical background.

Examples

```
airy_ai(2)
airy_bi(2)
airy_ai_prime(2)
airy_bi_prime(2)
airy_ai_zero(1)
airy_bi_zero(1)
airy_ai_zero(start_index = 1, number_of_zeros = 5)
airy_bi_zero(start_index = 1, number_of_zeros = 5)
```

`arcsine_distribution` *Arcsine Distribution Functions*

Description

Functions to compute the probability density function, cumulative distribution function, and quantile function for the arcsine distribution.

Usage

```
arcsine_pdf(x, x_min = 0, x_max = 1)

arcsine_lpdf(x, x_min = 0, x_max = 1)

arcsine_cdf(x, x_min = 0, x_max = 1)

arcsine_lcdf(x, x_min = 0, x_max = 1)

arcsine_quantile(p, x_min = 0, x_max = 1)
```

Arguments

`x`	quantile
`x_min`	minimum value of the distribution (default is 0)
`x_max`	maximum value of the distribution (default is 1)
`p`	probability

Value

A single numeric value with the computed probability density, log-probability density, cumulative distribution, log-cumulative distribution, or quantile depending on the function called.

See Also

Boost Documentation for more details on the mathematical background.

Examples

```
arcsine_pdf(0.5)
arcsine_lpdf(0.5)
arcsine_cdf(0.5)
arcsine_lcdf(0.5)
arcsine_quantile(0.5)
```

---

basic_functions *Basic Mathematical Functions*

Description

Functions to compute sine, cosine, logarithm, exponential, cube root, square root, power, hypotenuse, and inverse square root.

Usage

```
sin_pi(x)

cos_pi(x)

log1p_boost(x)

expm1_boost(x)

cbrt(x)

sqrt1pm1(x)

powm1(x, y)

hypot(x, y)

rsqrt(x)
```

Arguments

x	Input numeric value
y	Second input numeric value (for power and hypotenuse functions)

Value

A single numeric value with the computed result of the function.

See Also

Boost Documentation) for more details on the mathematical background.

Examples

```
# sin(pi * 0.5)
sin_pi(0.5)
# cos(pi * 0.5)
cos_pi(0.5)
# log(1 + 0.5)
log1p_boost(0.5)
# exp(0.5) - 1
expm1_boost(0.5)
cbrt(8)
# sqrt(1 + 0.5) - 1
sqrt1pm1(0.5)
# 2^3 - 1
powm1(2, 3)
hypot(3, 4)
rsqrt(4)
```

---

bernoulli_distribution

Bernoulli Distribution Functions

Description

Functions to compute the probability density function, cumulative distribution function, and quantile function for the Bernoulli distribution.

Usage

```
bernoulli_pdf(x, p_success)

bernoulli_lpdf(x, p_success)

bernoulli_cdf(x, p_success)

bernoulli_lcdf(x, p_success)

bernoulli_quantile(p, p_success)
```

Arguments

x	quantile (0 or 1)
p_success	probability of success (0 <= p_success <= 1)
p	probability (0 <= p <= 1)

Value

A single numeric value with the computed probability density, log-probability density, cumulative distribution, log-cumulative distribution, or quantile depending on the function called.

See Also

Boost Documentation for more details on the mathematical background.

Examples

```
bernoulli_pdf(1, 0.5)
bernoulli_lpdf(1, 0.5)
bernoulli_cdf(1, 0.5)
bernoulli_lcdf(1, 0.5)
bernoulli_quantile(0.5, 0.5)
```

---

bessel_functions *Bessel Functions, Their Derivatives, and Zeros*

Description

Functions to compute Bessel functions of the first and second kind, their modified versions, spherical Bessel functions, and their derivatives and zeros.

Usage

```
cyl_bessel_j(v, x)

cyl_neumann(v, x)

cyl_bessel_j_zero(v, m = NULL, start_index = NULL, number_of_zeros = NULL)

cyl_neumann_zero(v, m = NULL, start_index = NULL, number_of_zeros = NULL)

cyl_bessel_i(v, x)

cyl_bessel_k(v, x)

sph_bessel(v, x)

sph_neumann(v, x)
```

```
cyl_bessel_j_prime(v, x)

cyl_neumann_prime(v, x)

cyl_bessel_i_prime(v, x)

cyl_bessel_k_prime(v, x)

sph_bessel_prime(v, x)

sph_neumann_prime(v, x)
```

Arguments

v	Order of the Bessel function
x	Argument of the Bessel function
m	The index of the zero to find (1-based).
start_index	The starting index for the zeros (1-based).
number_of_zeros	The number of zeros to find.

Value

Single numeric value for the Bessel functions and their derivatives, or a vector of length number_of_zeros for the multiple zero functions.

See Also

Boost Documentation for more details on the mathematical background.

Examples

```
# Bessel function of the first kind J_0(1)
cyl_bessel_j(0, 1)
# Bessel function of the second kind Y_0(1)
cyl_neumann(0, 1)
# Modified Bessel function of the first kind I_0(1)
cyl_bessel_i(0, 1)
# Modified Bessel function of the second kind K_0(1)
cyl_bessel_k(0, 1)
# Spherical Bessel function of the first kind j_0(1)
sph_bessel(0, 1)
# Spherical Bessel function of the second kind y_0(1)
sph_neumann(0, 1)
# Derivative of the Bessel function of the first kind J_0(1)
cyl_bessel_j_prime(0, 1)
# Derivative of the Bessel function of the second kind Y_0(1)
cyl_neumann_prime(0, 1)
# Derivative of the modified Bessel function of the first kind I_0(1)
```

```
cyl_bessel_i_prime(0, 1)
# Derivative of the modified Bessel function of the second kind K_0(1)
cyl_bessel_k_prime(0, 1)
# Derivative of the spherical Bessel function of the first kind j_0(1)
sph_bessel_prime(0, 1)
# Derivative of the spherical Bessel function of the second kind y_0(1)
sph_neumann_prime(0, 1)
# Finding the first zero of the Bessel function of the first kind J_0
cyl_bessel_j_zero(0, 1)
# Finding the first zero of the Bessel function of the second kind Y_0
cyl_neumann_zero(0, 1)
# Finding multiple zeros of the Bessel function of the first kind J_0 starting from index 1
cyl_bessel_j_zero(0, start_index = 1, number_of_zeros = 5)
# Finding multiple zeros of the Bessel function of the second kind Y_0 starting from index 1
cyl_neumann_zero(0, start_index = 1, number_of_zeros = 5)
```

`beta_distribution` *Beta Distribution Functions*

Description

Functions to compute the probability density function, cumulative distribution function, and quantile function for the Beta distribution.

Usage

```
beta_pdf(x, alpha, beta)

beta_lpdf(x, alpha, beta)

beta_cdf(x, alpha, beta)

beta_lcdf(x, alpha, beta)

beta_quantile(p, alpha, beta)
```

Arguments

`x`	quantile (0 <= x <= 1)
`alpha`	shape parameter (alpha > 0)
`beta`	shape parameter (beta > 0)
`p`	probability (0 <= p <= 1)

Value

A single numeric value with the computed probability density, log-probability density, cumulative distribution, log-cumulative distribution, or quantile depending on the function called.

See Also

Boost Documentation for more details on the mathematical background.

Examples

```
# Beta distribution with shape parameters alpha = 2, beta = 5
beta_pdf(0.5, 2, 5)
beta_lpdf(0.5, 2, 5)
beta_cdf(0.5, 2, 5)
beta_lcdf(0.5, 2, 5)
beta_quantile(0.5, 2, 5)
```

---

beta_functions *Beta Functions*

Description

Functions to compute the Euler beta function, normalised incomplete beta function, and their complements, as well as their inverses and derivatives.

Usage

```
beta_boost(a, b, x = NULL)

ibeta(a, b, x)

ibetac(a, b, x)

betac(a, b, x)

ibeta_inv(a, b, p)

ibetac_inv(a, b, q)

ibeta_inva(b, x, p)

ibetac_inva(b, x, q)

ibeta_invb(a, x, p)

ibetac_invb(a, x, q)

ibeta_derivative(a, b, x)
```

Arguments

a	First parameter of the beta function
b	Second parameter of the beta function
x	Upper limit of integration (0 <= x <= 1)
p	Probability value (0 <= p <= 1)
q	Probability value (0 <= q <= 1)

Value

A single numeric value with the computed beta function, normalised incomplete beta function, or their complements, depending on the function called.

See Also

Boost Documentation for more details on the mathematical background.

Examples

```
## Not run:
# Euler beta function B(2, 3)
beta_boost(2, 3)
# Normalised incomplete beta function I_x(2, 3) for x = 0.5
ibeta(2, 3, 0.5)
# Normalised complement of the incomplete beta function 1 - I_x(2, 3) for x = 0.5
ibetac(2, 3, 0.5)
# Full incomplete beta function B_x(2, 3) for x = 0.5
beta_boost(2, 3, 0.5)
# Full complement of the incomplete beta function 1 - B_x(2, 3) for x = 0.5
betac(2, 3, 0.5)
# Inverse of the normalised incomplete beta function I_x(2, 3) = 0.5
ibeta_inv(2, 3, 0.5)
# Inverse of the normalised complement of the incomplete beta function I_x(2, 3) = 0.5
ibetac_inv(2, 3, 0.5)
# Inverse of the normalised complement of the incomplete beta function I_x(a, b)
# with respect to a for x = 0.5 and q = 0.5
ibetac_inva(3, 0.5, 0.5)
# Inverse of the normalised incomplete beta function I_x(a, b)
# with respect to b for x = 0.5 and p = 0.5
ibeta_invb(0.8, 0.5, 0.5)
# Inverse of the normalised complement of the incomplete beta function I_x(a, b)
# with respect to b for x = 0.5 and q = 0.5
ibetac_invb(2, 0.5, 0.5)
# Derivative of the incomplete beta function with respect to x for a = 2, b = 3, x = 0.5
ibeta_derivative(2, 3, 0.5)

## End(Not run)
```

`binomial_distribution` *Binomial Distribution Functions*

Description

Functions to compute the probability density function, cumulative distribution function, and quantile function for the Binomial distribution.

Usage

```
binomial_pdf(k, n, prob)

binomial_lpdf(k, n, prob)

binomial_cdf(k, n, prob)

binomial_lcdf(k, n, prob)

binomial_quantile(p, n, prob)
```

Arguments

k	number of successes (0 <= k <= n)
n	number of trials (n >= 0)
prob	probability of success on each trial (0 <= prob <= 1)
p	probability (0 <= p <= 1)

Value

A single numeric value with the computed probability density, log-probability density, cumulative distribution, log-cumulative distribution, or quantile depending on the function called.

See Also

Boost Documentation for more details on the mathematical background.

Examples

```
# Binomial dist ribution with n = 10, prob = 0.5
binomial_pdf(3, 10, 0.5)
binomial_lpdf(3, 10, 0.5)
binomial_cdf(3, 10, 0.5)
binomial_lcdf(3, 10, 0.5)
binomial_quantile(0.5, 10, 0.5)
```

cauchy_distribution *Cauchy Distribution Functions*

Description

Functions to compute the probability density function, cumulative distribution function, and quantile function for the Cauchy distribution.

Usage

```
cauchy_pdf(x, location = 0, scale = 1)

cauchy_lpdf(x, location = 0, scale = 1)

cauchy_cdf(x, location = 0, scale = 1)

cauchy_lcdf(x, location = 0, scale = 1)

cauchy_quantile(p, location = 0, scale = 1)
```

Arguments

x	quantile
location	location parameter (default is 0)
scale	scale parameter (default is 1)
p	probability (0 <= p <= 1)

Value

A single numeric value with the computed probability density, log-probability density, cumulative distribution, log-cumulative distribution, or quantile depending on the function called.

See Also

Boost Documentation for more details on the mathematical background.

Examples

```
# Cauchy distribution with location = 0, scale = 1
cauchy_pdf(0)
cauchy_lpdf(0)
cauchy_cdf(0)
cauchy_lcdf(0)
cauchy_quantile(0.5)
```

`chebyshev_polynomials` *Chebyshev Polynomials and Related Functions*

Description

Functions to compute Chebyshev polynomials of the first and second kind.

Usage

```
chebyshev_next(x, Tn, Tn_1)

chebyshev_t(n, x)

chebyshev_u(n, x)

chebyshev_t_prime(n, x)

chebyshev_clenshaw_recurrence(c, x)

chebyshev_clenshaw_recurrence_ab(c, a, b, x)
```

Arguments

`x`	Argument of the polynomial
`Tn`	Value of the Chebyshev polynomial $(T_n(x))$
`Tn_1`	Value of the Chebyshev polynomial $(T_{n-1}(x))$
`n`	Degree of the polynomial
`c`	Coefficients of the Chebyshev polynomial
`a`	Lower bound of the interval
`b`	Upper bound of the interval

Value

A single numeric value with the computed Chebyshev polynomial, its derivative, or related functions.

See Also

Boost Documentation for more details on the mathematical background.

Examples

```
# Chebyshev polynomial of the first kind T_2(0.5)
chebyshev_t(2, 0.5)
# Chebyshev polynomial of the second kind U_2(0.5)
chebyshev_u(2, 0.5)
# Derivative of the Chebyshev polynomial of the first kind T_2'(0.5)
chebyshev_t_prime(2, 0.5)
# Next Chebyshev polynomial of the first kind T_3(0.5) using T_2(0.5) and T_1(0.5)
chebyshev_next(0.5, chebyshev_t(2, 0.5), chebyshev_t(1, 0.5))
# Chebyshev polynomial of the first kind using Clenshaw's recurrence with coefficients
# c = c(1, 0, -1) at x = 0.5
chebyshev_clenshaw_recurrence(c(1, 0, -1), 0.5)
# Chebyshev polynomial of the first kind using Clenshaw's recurrence with interval [0, 1]
chebyshev_clenshaw_recurrence_ab(c(1, 0, -1), 0, 1, 0.5)
```

---

chi_squared_distribution

Chi-Squared Distribution Functions

Description

Functions to compute the probability density function, cumulative distribution function, and quantile function for the Chi-Squared distribution.

Usage

```
chi_squared_pdf(x, df)

chi_squared_lpdf(x, df)

chi_squared_cdf(x, df)

chi_squared_lcdf(x, df)

chi_squared_quantile(p, df)
```

Arguments

x	quantile
df	degrees of freedom (df > 0)
p	probability (0 <= p <= 1)

Value

A single numeric value with the computed probability density, log-probability density, cumulative distribution, log-cumulative distribution, or quantile depending on the function called.

See Also

Boost Documentation for more details on the mathematical background.

Examples

```
# Chi-Squared distribution with 3 degrees of freedom
chi_squared_pdf(2, 3)
chi_squared_lpdf(2, 3)
chi_squared_cdf(2, 3)
chi_squared_lcdf(2, 3)
chi_squared_quantile(0.5, 3)
```

`double_exponential_quadrature`
Double Exponential Quadrature

Description

Functions for numerical integration using double exponential quadrature methods such as tanh-sinh, sinh-sinh, and exp-sinh quadrature.

Usage

```
tanh_sinh(f, a, b, tol = sqrt(.Machine$double.eps), max_refinements = 15)

sinh_sinh(f, tol = sqrt(.Machine$double.eps), max_refinements = 9)

exp_sinh(f, a, b, tol = sqrt(.Machine$double.eps), max_refinements = 9)
```

Arguments

`f`	A function to integrate. It should accept a single numeric value and return a single numeric value.
`a`	The lower limit of integration.
`b`	The upper limit of integration.
`tol`	The tolerance for the approximation. Default is `sqrt(.Machine$double.eps)`.
`max_refinements`	The maximum number of refinements to apply. Default is 15 for tanh-sinh and 9 for sinh-sinh and exp-sinh.

Value

A single numeric value with the computed integral.

Examples

```
# Tanh-sinh quadrature of log(x) from 0 to 1
tanh_sinh(function(x) { log(x) * log1p(-x) }, a = 0, b = 1)
# Sinh-sinh quadrature of exp(-x^2)
sinh_sinh(function(x) { exp(-x * x) })
# Exp-sinh quadrature of exp(-3*x) from 0 to Inf
exp_sinh(function(x) { exp(-3 * x) }, a = 0, b = Inf)
```

---

elliptic_integrals *Elliptic Integrals*

Description

Functions to compute various elliptic integrals, including Carlson's elliptic integrals and incomplete elliptic integrals.

Usage

```
ellint_rf(x, y, z)

ellint_rd(x, y, z)

ellint_rj(x, y, z, p)

ellint_rc(x, y)

ellint_rg(x, y, z)

ellint_1(k, phi = NULL)

ellint_2(k, phi = NULL)

ellint_3(k, n, phi = NULL)

ellint_d(k, phi = NULL)

jacobi_zeta(k, phi)

heuman_lambda(k, phi)
```

Arguments

x	First parameter of the integral
y	Second parameter of the integral
z	Third parameter of the integral
p	Fourth parameter of the integral (for Rj)

k	Elliptic modulus (for incomplete elliptic integrals)
phi	Amplitude (for incomplete elliptic integrals)
n	Characteristic (for incomplete elliptic integrals of the third kind)

Value

A single numeric value with the computed elliptic integral.

See Also

Boost Documentation for more details on the mathematical background.

Examples

```
# Carlson's elliptic integral Rf with parameters x = 1, y = 2, z = 3
ellint_rf(1, 2, 3)
#' # Carlson's elliptic integral Rd with parameters x = 1, y = 2, z = 3
ellint_rd(1, 2, 3)
# Carlson's elliptic integral Rj with parameters x = 1, y = 2, z = 3, p = 4
ellint_rj(1, 2, 3, 4)
# Carlson's elliptic integral Rc with parameters x = 1, y = 2
ellint_rc(1, 2)
# Carlson's elliptic integral Rg with parameters x = 1, y = 2, z = 3
ellint_rg(1, 2, 3)
# Incomplete elliptic integral of the first kind with k = 0.5, phi = pi/4
ellint_1(0.5, pi / 4)
# Complete elliptic integral of the first kind
ellint_1(0.5)
# Incomplete elliptic integral of the second kind with k = 0.5, phi = pi/4
ellint_2(0.5, pi / 4)
# Complete elliptic integral of the second kind
ellint_2(0.5)
# Incomplete elliptic integral of the third kind with k = 0.5, n = 0.5, phi = pi/4
ellint_3(0.5, 0.5, pi / 4)
# Complete elliptic integral of the third kind with k = 0.5, n = 0.5
ellint_3(0.5, 0.5)
# Incomplete elliptic integral D with k = 0.5, phi = pi/4
ellint_d(0.5, pi / 4)
# Complete elliptic integral D
ellint_d(0.5)
# Jacobi zeta function with k = 0.5, phi = pi/4
jacobi_zeta(0.5, pi / 4)
# Heuman's lambda function with k = 0.5, phi = pi/4
heuman_lambda(0.5, pi / 4)
```

error_functions *Error Functions and Inverses*

Description

Functions to compute the error function, complementary error function, and their inverses.

Usage

```
erf(x)

erfc(x)

erf_inv(p)

erfc_inv(p)
```

Arguments

x	Input numeric value
p	Probability value (0 <= p <= 1)

Value

A single numeric value with the computed error function, complementary error function, or their inverses.

See Also

Boost Documentation for more details

Examples

```
# Error function
erf(0.5)
# Complementary error function
erfc(0.5)
# Inverse error function
erf_inv(0.5)
# Inverse complementary error function
erfc_inv(0.5)
```

`exponential_distribution` *Exponential Distribution Functions*

Description

Functions to compute the probability density function, cumulative distribution function, and quantile function for the Exponential distribution.

Usage

```
exponential_pdf(x, lambda)

exponential_lpdf(x, lambda)

exponential_cdf(x, lambda)

exponential_lcdf(x, lambda)

exponential_quantile(p, lambda)
```

Arguments

`x`	quantile
`lambda`	rate parameter (lambda > 0)
`p`	probability (0 <= p <= 1)

Value

A single numeric value with the computed probability density, log-probability density, cumulative distribution, log-cumulative distribution, or quantile depending on the function called.

See Also

Boost Documentation for more details on the mathematical background.

Examples

```
# Exponential distribution with rate parameter lambda = 2
exponential_pdf(1, 2)
exponential_lpdf(1, 2)
exponential_cdf(1, 2)
exponential_lcdf(1, 2)
exponential_quantile(0.5, 2)
```

exponential_integrals *Exponential Integrals*

Description

Functions to compute various exponential integrals, including En and Ei.

Usage

```
expint_en(n, z)

expint_ei(z)
```

Arguments

n	Order of the integral (for En)
z	Argument of the integral (for En and Ei)

Value

A single numeric value with the computed exponential integral.

See Also

Boost Documentation for

Examples

```
# Exponential integral En with n = 1 and z = 2
expint_en(1, 2)
# Exponential integral Ei with z = 2
expint_ei(2)
```

extreme_value_distribution
Extreme Value Distribution Functions

Description

Functions to compute the probability density function, cumulative distribution function, and quantile function for the Extreme Value distribution.

Usage

```
extreme_value_pdf(x, location = 0, scale = 1)

extreme_value_lpdf(x, location = 0, scale = 1)

extreme_value_cdf(x, location = 0, scale = 1)

extreme_value_lcdf(x, location = 0, scale = 1)

extreme_value_quantile(p, location = 0, scale = 1)
```

Arguments

x	quantile
location	location parameter (default is 0)
scale	scale parameter (default is 1)
p	probability (0 <= p <= 1)

Value

A single numeric value with the computed probability density, log-probability density, cumulative distribution, log-cumulative distribution, or quantile depending on the function called.

See Also

Boost Documentation for more details on the mathematical background.

Examples

```
# Extreme Value distribution with location = 0, scale = 1
extreme_value_pdf(0)
extreme_value_lpdf(0)
extreme_value_cdf(0)
extreme_value_lcdf(0)
extreme_value_quantile(0.5)
```

---

factorials_and_binomial_coefficients

Factorials and Binomial Coefficients

Description

Functions to compute factorials, double factorials, rising and falling factorials, and binomial coefficients.

Usage

```
factorial_boost(i)

unchecked_factorial(i)

max_factorial()

double_factorial(i)

rising_factorial(x, i)

falling_factorial(x, i)

binomial_coefficient(n, k)
```

Arguments

i	Non-negative integer input for factorials and double factorials.
x	Base value for rising and falling factorials.
n	Total number of elements for binomial coefficients.
k	Number of elements to choose for binomial coefficients.

Value

A single numeric value with the computed factorial, double factorial, rising factorial, falling factorial, or binomial coefficient.

See Also

Boost Documentation for more details on the mathematical background.

Examples

```
# Factorial of 5
factorial_boost(5)
# Unchecked factorial of 5 (using table lookup)
unchecked_factorial(5)
# Maximum factorial value that can be computed
max_factorial()
# Double factorial of 6
double_factorial(6)
# Rising factorial of 3 with exponent 2
rising_factorial(3, 2)
# Falling factorial of 3 with exponent 2
falling_factorial(3, 2)
# Binomial coefficient "5 choose 2"
binomial_coefficient(5, 2)
```

`fisher_f_distribution` *Fisher F Distribution Functions*

Description

Functions to compute the probability density function, cumulative distribution function, and quantile function for the Fisher F distribution.

Usage

```
fisher_f_pdf(x, df1, df2)

fisher_f_lpdf(x, df1, df2)

fisher_f_cdf(x, df1, df2)

fisher_f_lcdf(x, df1, df2)

fisher_f_quantile(p, df1, df2)
```

Arguments

`x`	quantile
`df1`	degrees of freedom for the numerator (df1 > 0)
`df2`	degrees of freedom for the denominator (df2 > 0)
`p`	probability (0 <= p <= 1)

Value

A single numeric value with the computed probability density, log-probability density, cumulative distribution, log-cumulative distribution, or quantile depending on the function called.

See Also

Boost Documentation for more details on the mathematical background.

Examples

```
# Fisher F distribution with df1 = 5, df2 = 2
fisher_f_pdf(1, 5, 2)
fisher_f_lpdf(1, 5, 2)
fisher_f_cdf(1, 5, 2)
fisher_f_lcdf(1, 5, 2)
fisher_f_quantile(0.5, 5, 2)
```

`gamma_distribution` *Gamma Distribution Functions*

Description

Functions to compute the probability density function, cumulative distribution function, and quantile function for the Gamma distribution.

Usage

```
gamma_pdf(x, shape, scale)

gamma_lpdf(x, shape, scale)

gamma_cdf(x, shape, scale)

gamma_lcdf(x, shape, scale)

gamma_quantile(p, shape, scale)
```

Arguments

`x`	quantile
`shape`	shape parameter (shape > 0)
`scale`	scale parameter (scale > 0)
`p`	probability (0 <= p <= 1)

Value

A single numeric value with the computed probability density, log-probability density, cumulative distribution, log-cumulative distribution, or quantile depending on the function called.

See Also

Boost Documentation for more details on the mathematical background.

Examples

```
# Gamma distribution with shape = 3, scale = 4
gamma_pdf(2, 3, 4)
gamma_lpdf(2, 3, 4)
gamma_cdf(2, 3, 4)
gamma_lcdf(2, 3, 4)
gamma_quantile(0.5, 3, 4)
```

gamma_functions *Gamma Functions*

Description

Functions to compute the gamma function, its logarithm, digamma, trigamma, polygamma, and various incomplete gamma functions.

Usage

```
tgamma(z)

tgamma1pm1(z)

lgamma_boost(z)

digamma_boost(z)

trigamma_boost(z)

polygamma(n, z)

tgamma_ratio(a, b)

tgamma_delta_ratio(a, delta)

gamma_p(a, z)

gamma_q(a, z)

tgamma_lower(a, z)

tgamma_upper(a, z)

gamma_q_inv(a, q)

gamma_p_inv(a, p)

gamma_q_inva(z, q)

gamma_p_inva(z, p)

gamma_p_derivative(a, z)
```

Arguments

z	Input numeric value for the gamma function

n	Order of the polygamma function (non-negative integer)
a	Argument for the incomplete gamma functions
b	Denominator argument for the ratio of gamma functions
delta	Increment for the ratio of gamma functions
q	Probability value for the incomplete gamma functions
p	Probability value for the incomplete gamma functions

Value

A single numeric value with the computed gamma function, logarithm, digamma, trigamma, polygamma, or incomplete gamma functions.

See Also

Boost Documentation for more details on the mathematical background.

Examples

```
## Not run:
# Gamma function for z = 5
tgamma(5)
# Gamma function for (1 + z) - 1, where z = 5
tgamma1pm1(5)
# Logarithm of the gamma function for z = 5
lgamma_boost(5)
# Digamma function for z = 5
digamma_boost(5)
# Trigamma function for z = 5
trigamma_boost(5)
# Polygamma function of order 1 for z = 5
polygamma(1, 5)
# Ratio of gamma functions for a = 5, b = 3
tgamma_ratio(5, 3)
# Ratio of gamma functions with delta for a = 5, delta = 2
tgamma_delta_ratio(5, 2)
# Normalised lower incomplete gamma function P(a, z) for a = 5, z = 2
gamma_p(5, 2)
# Normalised upper incomplete gamma function Q(a, z) for a = 5, z = 2
gamma_q(5, 2)
# Full lower incomplete gamma function for a = 5, z = 2
tgamma_lower(5, 2)
# Full upper incomplete gamma function for a = 5, z = 2
tgamma_upper(5, 2)
# Inverse of the normalised upper incomplete gamma function for a = 5, q = 0.5
gamma_q_inv(5, 0.5)
# Inverse of the normalised lower incomplete gamma function for a = 5, p = 0.5
gamma_p_inv(5, 0.5)
# Inverse of the normalised upper incomplete gamma function with respect to a for z = 2, q = 0.5
gamma_q_inva(2, 0.5)
# Inverse of the normalised lower incomplete gamma function with respect to a for z = 2, p = 0.5
```

```
gamma_p_inva(2, 0.5)
# Derivative of the normalised upper incomplete gamma function for a = 5, z = 2
gamma_p_derivative(5, 2)

## End(Not run)
```

---

gegenbauer_polynomials *Gegenbauer Polynomials and Related Functions*

Description

Functions to compute Gegenbauer polynomials, their derivatives, and related functions.

Usage

```
gegenbauer(n, lambda, x)

gegenbauer_prime(n, lambda, x)

gegenbauer_derivative(n, lambda, x, k)
```

Arguments

n	Degree of the polynomial
lambda	Parameter of the polynomial
x	Argument of the polynomial
k	Order of the derivative

Value

A single numeric value with the computed Gegenbauer polynomial, its derivative, or k-th derivative.

See Also

Boost Documentation for more details on the mathematical background.

Examples

```
# Gegenbauer polynomial C_2^(1)(0.5)
gegenbauer(2, 1, 0.5)
# Derivative of the Gegenbauer polynomial C_2^(1)'(0.5)
gegenbauer_prime(2, 1, 0.5)
# k-th derivative of the Gegenbauer polynomial C_2^(1)''(0.5)
gegenbauer_derivative(2, 1, 0.5, 2)
```

geometric_distribution *Geometric Distribution Functions*

Description

Functions to compute the probability density function, cumulative distribution function, and quantile function for the Geometric distribution.

Usage

```
geometric_pdf(x, prob)

geometric_lpdf(x, prob)

geometric_cdf(x, prob)

geometric_lcdf(x, prob)

geometric_quantile(p, prob)
```

Arguments

x	quantile (non-negative integer)
prob	probability of success (0 < prob < 1)
p	probability (0 <= p <= 1)

Value

A single numeric value with the computed probability density, log-probability density, cumulative distribution, log-cumulative distribution, or quantile depending on the function called.

See Also

Boost Documentation for more details on the mathematical background.

Examples

```
# Geometric distribution with probability of success prob = 0.5
geometric_pdf(3, 0.5)
geometric_lpdf(3, 0.5)
geometric_cdf(3, 0.5)
geometric_lcdf(3, 0.5)
geometric_quantile(0.5, 0.5)
```

hankel_functions *Hankel Functions*

Description

Functions to compute cyclic and spherical Hankel functions of the first and second kinds.

Usage

```
cyl_hankel_1(v, x)

cyl_hankel_2(v, x)

sph_hankel_1(v, x)

sph_hankel_2(v, x)
```

Arguments

v	Order of the Hankel function
x	Argument of the Hankel function

Value

A single complex value with the computed Hankel function.

See Also

Boost Documentation for more details on the mathematical background.

Examples

```
cyl_hankel_1(2, 0.5)
cyl_hankel_2(2, 0.5)
sph_hankel_1(2, 0.5)
sph_hankel_2(2, 0.5)
```

hermite_polynomials *Hermite Polynomials and Related Functions*

Description

Functions to compute Hermite polynomials.

Usage

```
hermite(n, x)

hermite_next(n, x, Hn, Hnm1)
```

Arguments

n	Degree of the polynomial
x	Argument of the polynomial
Hn	Value of the Hermite polynomial $(H_n(x))$
Hnm1	Value of the Hermite polynomial $(H_{n-1}(x))$

Value

A single numeric value with the computed Hermite polynomial or its next value.

See Also

Boost Documentation for more details on the mathematical background.

Examples

```
# Hermite polynomial H_2(0.5)
hermite(2, 0.5)
# Next Hermite polynomial H_3(0.5) using H_2(0.5) and H_1(0.5)
hermite_next(2, 0.5, hermite(2, 0.5), hermite(1, 0.5))
```

---

holtsmark_distribution

Holtsmark Distribution Functions

Description

Functions to compute the probability density function, cumulative distribution function, and quantile function for the Holtsmark distribution.

Usage

```
holtsmark_pdf(x, location = 0, scale = 1)

holtsmark_lpdf(x, location = 0, scale = 1)

holtsmark_cdf(x, location = 0, scale = 1)

holtsmark_lcdf(x, location = 0, scale = 1)

holtsmark_quantile(p, location = 0, scale = 1)
```

Arguments

x	quantile
location	location parameter (default is 0)
scale	scale parameter (default is 1)
p	probability (0 <= p <= 1)

Value

A single numeric value with the computed probability density, log-probability density, cumulative distribution, log-cumulative distribution, or quantile depending on the function called.

See Also

Boost Documentation for more details on the mathematical background.

Examples

```
# Distribution only available with Boost version 1.87.0 or later.
## Not run:
# Holtsmark distribution with location 0 and scale 1
  holtsmark_pdf(3)
  holtsmark_lpdf(3)
  holtsmark_cdf(3)
  holtsmark_lcdf(3)
  holtsmark_quantile(0.5)

## End(Not run)
```

---

hyperexponential_distribution

Hyperexponential Distribution Functions

Description

Functions to compute the probability density function, cumulative distribution function, and quantile function for the Hyperexponential distribution.

Usage

```
hyperexponential_pdf(x, probabilities, rates)

hyperexponential_lpdf(x, probabilities, rates)

hyperexponential_cdf(x, probabilities, rates)

hyperexponential_lcdf(x, probabilities, rates)

hyperexponential_quantile(p, probabilities, rates)
```

Arguments

x	quantile
probabilities	vector of probabilities (sum must be 1)
rates	vector of rates (all rates must be > 0)
p	probability (0 <= p <= 1)

Value

A single numeric value with the computed probability density, log-probability density, cumulative distribution, log-cumulative distribution, or quantile depending on the function called.

See Also

Boost Documentation for more details on the mathematical background.

Examples

```
# Hyperexponential distribution with probabilities = c(0.5, 0.5) and rates = c(1, 2)
hyperexponential_pdf(2, c(0.5, 0.5), c(1, 2))
hyperexponential_lpdf(2, c(0.5, 0.5), c(1, 2))
hyperexponential_cdf(2, c(0.5, 0.5), c(1, 2))
hyperexponential_lcdf(2, c(0.5, 0.5), c(1, 2))
hyperexponential_quantile(0.5, c(0.5, 0.5), c(1, 2))
```

---

hypergeometric_distribution

Hypergeometric Distribution Functions

Description

Functions to compute the probability density function, cumulative distribution function, and quantile function for the Hypergeometric distribution.

Usage

```
hypergeometric_pdf(x, r, n, N)

hypergeometric_lpdf(x, r, n, N)

hypergeometric_cdf(x, r, n, N)

hypergeometric_lcdf(x, r, n, N)

hypergeometric_quantile(p, r, n, N)
```

Arguments

x	quantile (non-negative integer)
r	number of successes in the population (r >= 0)
n	number of draws (n >= 0)
N	population size (N >= r)
p	probability (0 <= p <= 1)

Value

A single numeric value with the computed probability density, log-probability density, cumulative distribution, log-cumulative distribution, or quantile depending on the function called.

See Also

Boost Documentation for more details on the mathematical background.

Examples

```
# Hypergeometric distribution with r = 5, n = 10, N = 20
hypergeometric_pdf(3, 5, 10, 20)
hypergeometric_lpdf(3, 5, 10, 20)
hypergeometric_cdf(3, 5, 10, 20)
hypergeometric_lcdf(3, 5, 10, 20)
hypergeometric_quantile(0.5, 5, 10, 20)
```

---

hypergeometric_functions

Hypergeometric Functions

Description

Functions to compute various hypergeometric functions.

Usage

```
hypergeometric_1F0(a, z)

hypergeometric_0F1(b, z)

hypergeometric_2F0(a1, a2, z)

hypergeometric_1F1(a, b, z)

hypergeometric_1F1_regularized(a, b, z)

log_hypergeometric_1F1(a, b, z)

hypergeometric_pFq(a, b, z)
```

Arguments

a	Parameter of the hypergeometric function
z	Argument of the hypergeometric function
b	Second parameter of the hypergeometric function
a1	First parameter of the hypergeometric function
a2	Second parameter of the hypergeometric function

Value

A single numeric value with the computed hypergeometric function.

See Also

Boost Documentation for more details on the mathematical background.

Examples

```
# Hypergeometric Function 1F0
hypergeometric_1F0(2, 0.2)
# Hypergeometric Function 0F1
hypergeometric_0F1(1, 0.8)
# Hypergeometric Function 2F0
hypergeometric_2F0(0.1, -1, 0.1)
# Hypergeometric Function 1F1
hypergeometric_1F1(2, 3, 1)
# Regularised Hypergeometric Function 1F1
hypergeometric_1F1_regularized(2, 3, 1)
# Logarithm of the Hypergeometric Function 1F1
log_hypergeometric_1F1(2, 3, 1)
# Hypergeometric Function pFq
hypergeometric_pFq(c(2, 3), c(4, 5), 6)
```

---

inverse_chi_squared_distribution

Inverse Chi-Squared Distribution Functions

Description

Functions to compute the probability density function, cumulative distribution function, and quantile function for the Inverse Chi-Squared distribution.

Usage

```
inverse_chi_squared_pdf(x, df, scale = 1)

inverse_chi_squared_lpdf(x, df, scale = 1)

inverse_chi_squared_cdf(x, df, scale = 1)

inverse_chi_squared_lcdf(x, df, scale = 1)

inverse_chi_squared_quantile(p, df, scale = 1)
```

Arguments

x	quantile
df	degrees of freedom (df > 0)
scale	scale parameter (default is 1)
p	probability (0 <= p <= 1)

Value

A single numeric value with the computed probability density, log-probability density, cumulative distribution, log-cumulative distribution, or quantile depending on the function called.

See Also

Boost Documentation for more details on the mathematical background.

Examples

```
# Inverse Chi-Squared distribution with 3 degrees of freedom, scale = 1
inverse_chi_squared_pdf(2, 3, 1)
inverse_chi_squared_lpdf(2, 3, 1)
inverse_chi_squared_cdf(2, 3, 1)
inverse_chi_squared_lcdf(2, 3, 1)
inverse_chi_squared_quantile(0.5, 3, 1)
```

---

inverse_gamma_distribution

Inverse Gamma Distribution Functions

Description

Functions to compute the probability density function, cumulative distribution function, and quantile function for the Inverse Gamma distribution.

Usage

```
inverse_gamma_pdf(x, shape, scale)

inverse_gamma_lpdf(x, shape, scale)

inverse_gamma_cdf(x, shape, scale)

inverse_gamma_lcdf(x, shape, scale)

inverse_gamma_quantile(p, shape, scale)
```

Arguments

x	quantile
shape	shape parameter (shape > 0)
scale	scale parameter (scale > 0)
p	probability (0 <= p <= 1)

Value

A single numeric value with the computed probability density, log-probability density, cumulative distribution, log-cumulative distribution, or quantile depending on the function called.

See Also

Boost Documentation for more details on the mathematical background.

Examples

```
# Inverse Gamma distribution with shape = 3, scale = 4
inverse_gamma_pdf(2, 3, 4)
inverse_gamma_lpdf(2, 3, 4)
inverse_gamma_cdf(2, 3, 4)
inverse_gamma_lcdf(2, 3, 4)
inverse_gamma_quantile(0.5, 3, 4)
```

---

inverse_gaussian_distribution

Inverse Gaussian Distribution Functions

Description

Functions to compute the probability density function, cumulative distribution function, and quantile function for the Inverse Gaussian distribution.

Usage

```
inverse_gaussian_pdf(x, mu, lambda)

inverse_gaussian_lpdf(x, mu, lambda)

inverse_gaussian_cdf(x, mu, lambda)

inverse_gaussian_lcdf(x, mu, lambda)

inverse_gaussian_quantile(p, mu, lambda)
```

Arguments

x	quantile
mu	mean parameter (mu > 0)
lambda	scale (precision) parameter (lambda > 0)
p	probability (0 <= p <= 1)

Value

A single numeric value with the computed probability density, log-probability density, cumulative distribution, log-cumulative distribution, or quantile depending on the function called.

See Also

Boost Documentation for more details on the mathematical background.

Examples

```
# Inverse Gaussian distribution with mu = 3, lambda = 4
inverse_gaussian_pdf(2, 3, 4)
inverse_gaussian_lpdf(2, 3, 4)
inverse_gaussian_cdf(2, 3, 4)
inverse_gaussian_lcdf(2, 3, 4)
inverse_gaussian_quantile(0.5, 3, 4)
```

---

inverse_hyperbolic_functions

Inverse Hyperbolic Functions

Description

Functions to compute the inverse hyperbolic functions: acosh, asinh, and atanh.

Usage

```
acosh_boost(x)

asinh_boost(x)

atanh_boost(x)
```

Arguments

x	Input numeric value

Value

A single numeric value with the computed inverse hyperbolic function.

See Also

Boost Documentation for more details on the mathematical background.

Examples

```
# Inverse Hyperbolic Cosine
acosh_boost(2)
# Inverse Hyperbolic Sine
asinh_boost(1)
# Inverse Hyperbolic Tangent
atanh_boost(0.5)
```

---

jacobi_elliptic_functions

Jacobi Elliptic Functions

Description

Functions to compute the Jacobi elliptic functions: sn, cn, dn, and others.

Usage

```
jacobi_elliptic(k, u)

jacobi_cd(k, u)

jacobi_cn(k, u)

jacobi_cs(k, u)

jacobi_dc(k, u)
```

```
jacobi_dn(k, u)

jacobi_ds(k, u)

jacobi_nc(k, u)

jacobi_nd(k, u)

jacobi_ns(k, u)

jacobi_sc(k, u)

jacobi_sd(k, u)

jacobi_sn(k, u)
```

Arguments

k	Elliptic modulus (0 <= k < 1)
u	Argument of the elliptic functions

Value

For `jacobi_elliptic`, a list containing the values of the Jacobi elliptic functions: `sn`, `cn`, `dn`. For individual functions, a single numeric value is returned.

See Also

Boost Documentation for more details on the mathematical background.

Examples

```
# Jacobi Elliptic Functions
k <- 0.5
u <- 2
jacobi_elliptic(k, u)
# Individual Jacobi Elliptic Functions
jacobi_cd(k, u)
jacobi_cn(k, u)
jacobi_cs(k, u)
jacobi_dc(k, u)
jacobi_dn(k, u)
jacobi_ds(k, u)
jacobi_nc(k, u)
jacobi_nd(k, u)
jacobi_ns(k, u)
jacobi_sc(k, u)
jacobi_sd(k, u)
jacobi_sn(k, u)
```

`jacobi_polynomials` *Jacobi Polynomials and Related Functions*

Description

Functions to compute Jacobi polynomials, their derivatives, and related functions.

Usage

```
jacobi(n, alpha, beta, x)

jacobi_prime(n, alpha, beta, x)

jacobi_double_prime(n, alpha, beta, x)

jacobi_derivative(n, alpha, beta, x, k)
```

Arguments

`n`	Degree of the polynomial
`alpha`	First parameter of the polynomial
`beta`	Second parameter of the polynomial
`x`	Argument of the polynomial
`k`	Order of the derivative

Value

A single numeric value with the computed Jacobi polynomial, its derivative, or k-th derivative.

See Also

Boost Documentation for more details on the mathematical background.

Examples

```
# Jacobi polynomial P_2^(1, 2)(0.5)
jacobi(2, 1, 2, 0.5)
# Derivative of the Jacobi polynomial P_2^(1, 2)'(0.5)
jacobi_prime(2, 1, 2, 0.5)
# Second derivative of the Jacobi polynomial P_2^(1, 2)''(0.5)
jacobi_double_prime(2, 1, 2, 0.5)
# 3rd derivative of the Jacobi polynomial P_2^(1, 2)^(k)(0.5)
jacobi_derivative(2, 1, 2, 0.5, 3)
```

`jacobi_theta_functions` *Jacobi Theta Functions*

Description

Functions to compute the Jacobi theta functions $(\theta_1, \theta_2, \theta_3, \theta_4)$ parameterised by either (q) or (τ).

Usage

```
jacobi_theta1(x, q)

jacobi_theta1tau(x, tau)

jacobi_theta2(x, q)

jacobi_theta2tau(x, tau)

jacobi_theta3(x, q)

jacobi_theta3tau(x, tau)

jacobi_theta3m1(x, q)

jacobi_theta3m1tau(x, tau)

jacobi_theta4(x, q)

jacobi_theta4tau(x, tau)

jacobi_theta4m1(x, q)

jacobi_theta4m1tau(x, tau)
```

Arguments

x	Input value
q	The nome parameter of the Jacobi theta function (0 < q < 1)
tau	The nome parameter of the Jacobi theta function (tau = u + iv, where u and v are real numbers)

Value

A single numeric value with the computed Jacobi theta function.

See Also

Boost Documentation for more details on the mathematical background.

Examples

```
# Jacobi Theta Functions
x <- 0.5
q <- 0.9
tau <- 1.5
jacobi_theta1(x, q)
jacobi_theta1tau(x, tau)
jacobi_theta2(x, q)
jacobi_theta2tau(x, tau)
jacobi_theta3(x, q)
jacobi_theta3tau(x, tau)
jacobi_theta3m1(x, q)
jacobi_theta3m1tau(x, tau)
jacobi_theta4(x, q)
jacobi_theta4tau(x, tau)
jacobi_theta4m1(x, q)
jacobi_theta4m1tau(x, tau)
```

---

kolmogorov_smirnov_distribution

Kolmogorov-Smirnov Distribution Functions

Description

Functions to compute the probability density function, cumulative distribution function, and quantile function for the Kolmogorov-Smirnov distribution.

Usage

```
kolmogorov_smirnov_pdf(x, n)

kolmogorov_smirnov_lpdf(x, n)

kolmogorov_smirnov_cdf(x, n)

kolmogorov_smirnov_lcdf(x, n)

kolmogorov_smirnov_quantile(p, n)
```

Arguments

x	quantile
n	sample size (n > 0)
p	probability (0 <= p <= 1)

Value

A single numeric value with the computed probability density, log-probability density, cumulative distribution, log-cumulative distribution, or quantile depending on the function called.

See Also

Boost Documentation for more details on the mathematical background.

Examples

```
# Kolmogorov-Smirnov distribution with sample size n = 10
kolmogorov_smirnov_pdf(0.5, 10)
kolmogorov_smirnov_lpdf(0.5, 10)
kolmogorov_smirnov_cdf(0.5, 10)
kolmogorov_smirnov_lcdf(0.5, 10)
kolmogorov_smirnov_quantile(0.5, 10)
```

---

laguerre_polynomials *Laguerre Polynomials and Related Functions*

Description

Functions to compute Laguerre polynomials of the first kind.

Usage

```
laguerre(n, x)

laguerre_m(n, m, x)

laguerre_next(n, x, Ln, Lnm1)

laguerre_next_m(n, m, x, Ln, Lnm1)
```

Arguments

n	Degree of the polynomial
x	Argument of the polynomial
m	Order of the polynomial (for Laguerre polynomials of the first kind)
Ln	Value of the Laguerre polynomial $(L_n(x))$
Lnm1	Value of the Laguerre polynomial $(L_{n-1}(x))$

Value

A single numeric value with the computed Laguerre polynomial, its derivative, or related functions.

See Also

Boost Documentation for more details on the mathematical background.

Examples

```
# Laguerre polynomial of the first kind L_2(0.5)
laguerre(2, 0.5)
# Laguerre polynomial of the first kind with order 1 L_2^1(0.5)
laguerre_m(2, 1, 0.5)
# Next Laguerre polynomial of the first kind L_3(0.5) using L_2(0.5) and L_1(0.5)
laguerre_next(2, 0.5, laguerre(2, 0.5), laguerre(1, 0.5))
# Next Laguerre polynomial of the first kind with order 1 L_3^1(0.5) using L_2^1(0.5) and L_1^1(0.5)
laguerre_next_m(2, 1, 0.5, laguerre_m(2, 1, 0.5), laguerre_m(1, 1, 0.5))
```

---

lambert_w_function *Lambert W Function and Its Derivatives*

Description

Functions to compute the Lambert W function and its derivatives for the principal branch (W_0) and the branch -1 (W_{-1}).

Usage

```
lambert_w0(z)

lambert_wm1(z)

lambert_w0_prime(z)

lambert_wm1_prime(z)
```

Arguments

z	Argument of the Lambert W function

Value

A single numeric value with the computed Lambert W function or its derivative.

See Also

Boost Documentation for more details on the mathematical background.

Examples

```
# Lambert W Function (Principal Branch)
lambert_w0(0.3)
# Lambert W Function (Branch -1)
lambert_wm1(-0.3)
# Derivative of the Lambert W Function (Principal Branch)
lambert_w0_prime(0.3)
# Derivative of the Lambert W Function (Branch -1)
lambert_wm1_prime(-0.3)
```

`landau_distribution` *Landau Distribution Functions*

Description

Functions to compute the probability density function, cumulative distribution function, and quantile function for the Landau distribution.

Usage

```
landau_pdf(x, location = 0, scale = 1)

landau_lpdf(x, location = 0, scale = 1)

landau_cdf(x, location = 0, scale = 1)

landau_lcdf(x, location = 0, scale = 1)

landau_quantile(p, location = 0, scale = 1)
```

Arguments

`x`	quantile
`location`	location parameter (default is 0)
`scale`	scale parameter (default is 1)
`p`	probability (0 <= p <= 1)

Value

A single numeric value with the computed probability density, log-probability density, cumulative distribution, log-cumulative distribution, or quantile depending on the function called.

See Also

Boost Documentation for more details on the mathematical background.

Examples

```
# Distribution only available with Boost version 1.87.0 or later.
## Not run:
# Landau distribution with location 0 and scale 1
  landau_pdf(3)
  landau_lpdf(3)
  landau_cdf(3)
  landau_lcdf(3)
  landau_quantile(0.5)

## End(Not run)
```

`laplace_distribution` *Laplace Distribution Functions*

Description

Functions to compute the probability density function, cumulative distribution function, and quantile function for the Laplace distribution.

Usage

```
laplace_pdf(x, location = 0, scale = 1)

laplace_lpdf(x, location = 0, scale = 1)

laplace_cdf(x, location = 0, scale = 1)

laplace_lcdf(x, location = 0, scale = 1)

laplace_quantile(p, location = 0, scale = 1)
```

Arguments

`x`	quantile
`location`	location parameter (default is 0)
`scale`	scale parameter (default is 1)
`p`	probability (0 <= p <= 1)

Value

A single numeric value with the computed probability density, log-probability density, cumulative distribution, log-cumulative distribution, or quantile depending on the function called.

See Also

Boost Documentation for more details on the mathematical background.

Examples

```
# Laplace distribution with location = 0, scale = 1
laplace_pdf(0)
laplace_lpdf(0)
laplace_cdf(0)
laplace_lcdf(0)
laplace_quantile(0.5)
```

`legendre_polynomials` *Legendre Polynomials and Related Functions*

Description

Functions to compute Legendre polynomials of the first and second kind, their derivatives, zeros, and related functions.

Usage

```
legendre_p(n, x)

legendre_p_prime(n, x)

legendre_p_zeros(n)

legendre_p_m(n, m, x)

legendre_q(n, x)

legendre_next(n, x, Pl, Plm1)

legendre_next_m(n, m, x, Pl, Plm1)
```

Arguments

`n`	Degree of the polynomial
`x`	Argument of the polynomial
`m`	Order of the polynomial (for Legendre polynomials of the first kind)
`Pl`	Value of the Legendre polynomial $(P_l(x))$
`Plm1`	Value of the Legendre polynomial $(P_{l-1}(x))$

Value

A single numeric value with the computed Legendre polynomial, its derivative, zeros, or related functions.

See Also

Boost Documentation for more details on the mathematical background.

Examples

```
# Legendre polynomial of the first kind P_2(0.5)
legendre_p(2, 0.5)
# Derivative of the Legendre polynomial of the first kind P_2'(0.5)
legendre_p_prime(2, 0.5)
```

```
# Zeros of the Legendre polynomial of the first kind P_2
legendre_p_zeros(2)
# Legendre polynomial of the first kind with order 1 P_2^1(0.5)
legendre_p_m(2, 1, 0.5)
# Legendre polynomial of the second kind Q_2(0.5)
legendre_q(2, 0.5)
# Next Legendre polynomial of the first kind P_3(0.5) using P_2(0.5) and P_1(0.5)
legendre_next(2, 0.5, legendre_p(2, 0.5), legendre_p(1, 0.5))
# Next Legendre polynomial of the first kind with order 1 P_3^1(0.5) using P_2^1(0.5) and P_1^1(0.5)
legendre_next_m(2, 1, 0.5, legendre_p_m(2, 1, 0.5), legendre_p_m(1, 1, 0.5))
```

`logistic_distribution` *Logistic Distribution Functions*

Description

Functions to compute the probability density function, cumulative distribution function, and quantile function for the Logistic distribution.

Usage

```
logistic_pdf(x, location = 0, scale = 1)

logistic_lpdf(x, location = 0, scale = 1)

logistic_cdf(x, location = 0, scale = 1)

logistic_lcdf(x, location = 0, scale = 1)

logistic_quantile(p, location = 0, scale = 1)
```

Arguments

`x`	quantile
`location`	location parameter (default is 0)
`scale`	scale parameter (default is 1)
`p`	probability (0 <= p <= 1)

Value

A single numeric value with the computed probability density, log-probability density, cumulative distribution, log-cumulative distribution, or quantile depending on the function called.

See Also

Boost Documentation for more details on the mathematical background.

Examples

```
# Logistic distribution with location = 0, scale = 1
logistic_pdf(0)
logistic_lpdf(0)
logistic_cdf(0)
logistic_lcdf(0)
logistic_quantile(0.5)
```

`lognormal_distribution`

Log Normal Distribution Functions

Description

Functions to compute the probability density function, cumulative distribution function, and quantile function for the Log Normal distribution.

Usage

```
lognormal_pdf(x, location = 0, scale = 1)

lognormal_lpdf(x, location = 0, scale = 1)

lognormal_cdf(x, location = 0, scale = 1)

lognormal_lcdf(x, location = 0, scale = 1)

lognormal_quantile(p, location = 0, scale = 1)
```

Arguments

`x`	quantile
`location`	location parameter (default is 0)
`scale`	scale parameter (default is 1)
`p`	probability (0 <= p <= 1)

Value

A single numeric value with the computed probability density, log-probability density, cumulative distribution, log-cumulative distribution, or quantile depending on the function called.

See Also

Boost Documentation for more details on the mathematical background.

Examples

```
# Log Normal distribution with location = 0, scale = 1
lognormal_pdf(0)
lognormal_lpdf(0)
lognormal_cdf(0)
lognormal_lcdf(0)
lognormal_quantile(0.5)
```

`mapairy_distribution` *Map-Airy Distribution Functions*

Description

Functions to compute the probability density function, cumulative distribution function, and quantile function for the Map-Airy distribution.

Usage

```
mapairy_pdf(x, location = 0, scale = 1)

mapairy_lpdf(x, location = 0, scale = 1)

mapairy_cdf(x, location = 0, scale = 1)

mapairy_lcdf(x, location = 0, scale = 1)

mapairy_quantile(p, location = 0, scale = 1)
```

Arguments

`x`	quantile
`location`	location parameter (default is 0)
`scale`	scale parameter (default is 1)
`p`	probability (0 <= p <= 1)

Value

A single numeric value with the computed probability density, log-probability density, cumulative distribution, log-cumulative distribution, or quantile depending on the function called.

See Also

Boost Documentation for more details on the mathematical background.

Examples

```
# Distribution only available with Boost version 1.87.0 or later.
## Not run:
# Map-Airy distribution with location 0 and scale 1
  mapairy_pdf(3)
  mapairy_lpdf(3)
  mapairy_cdf(3)
  mapairy_lcdf(3)
  mapairy_quantile(0.5)

## End(Not run)
```

`negative_binomial_distribution`

Negative Binomial Distribution Functions

Description

Functions to compute the probability density function, cumulative distribution function, and quantile function for the Negative Binomial distribution.

Usage

```
negative_binomial_pdf(x, successes, success_fraction)

negative_binomial_lpdf(x, successes, success_fraction)

negative_binomial_cdf(x, successes, success_fraction)

negative_binomial_lcdf(x, successes, success_fraction)

negative_binomial_quantile(p, successes, success_fraction)
```

Arguments

`x`	quantile
`successes`	number of successes (successes >= 0)
`success_fraction`	probability of success on each trial (0 <= success_fraction <= 1)
`p`	probability (0 <= p <= 1)

Value

A single numeric value with the computed probability density, log-probability density, cumulative distribution, log-cumulative distribution, or quantile depending on the function called.

See Also

Boost Documentation for more details on the mathematical background.

Examples

```
negative_binomial_pdf(3, 5, 0.5)
negative_binomial_lpdf(3, 5, 0.5)
negative_binomial_cdf(3, 5, 0.5)
negative_binomial_lcdf(3, 5, 0.5)
negative_binomial_quantile(0.5, 5, 0.5)
```

---

non_central_beta_distribution

Noncentral Beta Distribution Functions

Description

Functions to compute the probability density function, cumulative distribution function, and quantile function for the Noncentral Beta distribution.

Usage

```
non_central_beta_pdf(x, alpha, beta, lambda)

non_central_beta_lpdf(x, alpha, beta, lambda)

non_central_beta_cdf(x, alpha, beta, lambda)

non_central_beta_lcdf(x, alpha, beta, lambda)

non_central_beta_quantile(p, alpha, beta, lambda)
```

Arguments

x	quantile (0 <= x <= 1)
alpha	first shape parameter (alpha > 0)
beta	second shape parameter (beta > 0)
lambda	noncentrality parameter (lambda >= 0)
p	probability (0 <= p <= 1)

Value

A single numeric value with the computed probability density, log-probability density, cumulative distribution, log-cumulative distribution, or quantile depending on the function called.

See Also

Boost Documentation for more details on the mathematical background.

Examples

```
# Noncentral Beta distribution with shape parameters alpha = 2, beta = 3
# and noncentrality parameter lambda = 1
non_central_beta_pdf(0.5, 2, 3, 1)
non_central_beta_lpdf(0.5, 2, 3, 1)
non_central_beta_cdf(0.5, 2, 3, 1)
non_central_beta_lcdf(0.5, 2, 3, 1)
non_central_beta_quantile(0.5, 2, 3, 1)
```

---

non_central_chi_squared_distribution

Noncentral Chi-Squared Distribution Functions

Description

Functions to compute the probability density function, cumulative distribution function, and quantile function for the Noncentral Chi-Squared distribution.

Usage

```
non_central_chi_squared_pdf(x, df, lambda)

non_central_chi_squared_lpdf(x, df, lambda)

non_central_chi_squared_cdf(x, df, lambda)

non_central_chi_squared_lcdf(x, df, lambda)

non_central_chi_squared_quantile(p, df, lambda)
```

Arguments

x	quantile
df	degrees of freedom (df > 0)
lambda	noncentrality parameter (lambda >= 0)
p	probability (0 <= p <= 1)

Value

A single numeric value with the computed probability density, log-probability density, cumulative distribution, log-cumulative distribution, or quantile depending on the function called.

See Also

Boost Documentation for more details on the mathematical background.

Examples

```
## Not run:
# Noncentral Chi-Squared distribution with 3 degrees of freedom and noncentrality
# parameter 1
non_central_chi_squared_pdf(2, 3, 1)
non_central_chi_squared_lpdf(2, 3, 1)
non_central_chi_squared_cdf(2, 3, 1)
non_central_chi_squared_lcdf(2, 3, 1)
non_central_chi_squared_quantile(0.5, 3, 1)

## End(Not run)
```

---

non_central_t_distribution

Noncentral T Distribution Functions

Description

Functions to compute the probability density function, cumulative distribution function, and quantile function for the Noncentral T distribution.

Usage

```
non_central_t_pdf(x, df, delta)

non_central_t_lpdf(x, df, delta)

non_central_t_cdf(x, df, delta)

non_central_t_lcdf(x, df, delta)

non_central_t_quantile(p, df, delta)
```

Arguments

x	quantile
df	degrees of freedom (df > 0)
delta	noncentrality parameter (delta >= 0)
p	probability (0 <= p <= 1)

Value

A single numeric value with the computed probability density, log-probability density, cumulative distribution, log-cumulative distribution, or quantile depending on the function called.

See Also

Boost Documentation for more details on the mathematical background.

Examples

```
# Noncentral T distribution with 3 degrees of freedom and noncentrality parameter 1
non_central_t_pdf(0, 3, 1)
non_central_t_lpdf(0, 3, 1)
non_central_t_cdf(0, 3, 1)
non_central_t_lcdf(0, 3, 1)
non_central_t_quantile(0.5, 3, 1)
```

---

normal_distribution *Normal Distribution Functions*

Description

Functions to compute the probability density function, cumulative distribution function, and quantile function for the Normal distribution.

Usage

```
normal_pdf(x, mean = 0, sd = 1)

normal_lpdf(x, mean = 0, sd = 1)

normal_cdf(x, mean = 0, sd = 1)

normal_lcdf(x, mean = 0, sd = 1)

normal_quantile(p, mean = 0, sd = 1)
```

Arguments

x	quantile
mean	mean parameter (default is 0)
sd	standard deviation parameter (default is 1)
p	probability (0 <= p <= 1)

Value

A single numeric value with the computed probability density, log-probability density, cumulative distribution, log-cumulative distribution, or quantile depending on the function called.

See Also

Boost Documentation for more details on the mathematical background.

Examples

```
# Normal distribution with mean = 0, sd = 1
normal_pdf(0)
normal_lpdf(0)
normal_cdf(0)
normal_lcdf(0)
normal_quantile(0.5)
```

`number_series` *Number Series*

Description

Functions to compute Bernoulli numbers, tangent numbers, fibonacci numbers, and prime numbers.

Usage

```
bernoulli_b2n(n = NULL, start_index = NULL, number_of_bernoullis_b2n = NULL)

max_bernoulli_b2n()

unchecked_bernoulli_b2n(n)

tangent_t2n(n = NULL, start_index = NULL, number_of_tangent_t2n = NULL)

prime(n)

max_prime()

fibonacci(n)

unchecked_fibonacci(n)
```

Arguments

`n`	Index of number to compute (must be a non-negative integer)
`start_index`	The starting index for the range of numbers (must be a non-negative integer)
`number_of_bernoullis_b2n`	The number of Bernoulli numbers to compute
`number_of_tangent_t2n`	The number of tangent numbers to compute

Details

Efficient computation of Bernoulli numbers, tangent numbers, fibonacci numbers, and prime numbers.

The `checked_` functions ensure that the input is within valid bounds, while the `unchecked_` functions do not perform such checks, allowing for potentially faster computation at the risk of overflow or invalid input.

The `max_` functions return the maximum index for which the respective numbers can be computed using precomputed lookup tables.

Value

A single numeric value for the Bernoulli numbers, tangent numbers, fibonacci numbers, or prime numbers, or a vector of values for ranges.

See Also

Boost Documentation for more details on the mathematical background.

Examples

```
bernoulli_b2n(10)
max_bernoulli_b2n()
unchecked_bernoulli_b2n(10)
bernoulli_b2n(start_index = 0, number_of_bernoullis_b2n = 10)
tangent_t2n(10)
tangent_t2n(start_index = 0, number_of_tangent_t2n = 10)
prime(10)
max_prime()
fibonacci(10)
unchecked_fibonacci(10)
```

`numerical_differentiation` *Numerical Differentiation*

Description

Functions for numerical differentiation using finite difference methods and complex step methods.

Usage

```
finite_difference_derivative(f, x, order = 1)

complex_step_derivative(f, x)
```

Arguments

f	A function to differentiate. It should accept a single numeric value and return a single numeric value.
x	The point at which to evaluate the derivative.
order	The order of accuracy of the derivative to compute. Default is 1.

Value

The approximate value of the derivative at the point x.

Examples

```
# Finite difference derivative of sin(x) at pi/4
finite_difference_derivative(sin, pi / 4)
# Complex step derivative of exp(x) at 1.7
complex_step_derivative(exp, 1.7)
```

---

numerical_integration *Numerical Integration*

Description

Functions for numerical integration using various methods such as trapezoidal rule, Gauss-Legendre quadrature, and Gauss-Kronrod quadrature.

Usage

```
trapezoidal(f, a, b, tol = sqrt(.Machine$double.eps), max_refinements = 12)

gauss_legendre(f, a, b, points = 7)

gauss_kronrod(
  f,
  a,
  b,
  points = 15,
  max_depth = 15,
  tol = sqrt(.Machine$double.eps)
)
```

Arguments

f	A function to integrate. It should accept a single numeric value and return a single numeric value.
a	The lower limit of integration.
b	The upper limit of integration.

tol	The tolerance for the approximation. Default is sqrt(.Machine$double.eps).
max_refinements	The maximum number of refinements to apply. Default is 12.
points	The number of evaluation points to use in the Gauss-Legendre or Gauss-Kronrod quadrature.
max_depth	Sets the maximum number of interval splittings for Gauss-Kronrod permitted before stopping. Set this to zero for non-adaptive quadrature.

Value

A single numeric value with the computed integral.

Examples

```
# Trapezoidal rule integration of sin(x) from 0 to pi
trapezoidal(sin, 0, pi)
# Gauss-Legendre integration of exp(x) from 0 to 1
gauss_legendre(exp, 0, 1, points = 7)
# Adaptive Gauss-Kronrod integration of log(x) from 1 to 2
gauss_kronrod(log, 1, 2, points = 15, max_depth = 10)
```

---

ooura_fourier_integrals

Ooura Fourier Integrals

Description

Computing Fourier sine and cosine integrals using Ooura's method.

Usage

```
ooura_fourier_sin(
  f,
  omega = 1,
  relative_error_tolerance = sqrt(.Machine$double.eps),
  levels = 8
)

ooura_fourier_cos(
  f,
  omega = 1,
  relative_error_tolerance = sqrt(.Machine$double.eps),
  levels = 8
)
```

Arguments

f	A function to integrate. It should accept a single numeric value and return a single numeric value.
omega	The frequency parameter for the sine integral.
relative_error_tolerance	The relative error tolerance for the approximation.
levels	The number of levels of refinement to apply. Default is 8.

Value

A single numeric value with the computed Fourier sine or cosine integral, with attribute 'relative_error' indicating the relative error of the approximation.

Examples

```
# Fourier sine integral of sin(x) with omega = 1
ooura_fourier_sin(function(x) { 1 / x }, omega = 1)
# Fourier cosine integral of cos(x) with omega = 1
ooura_fourier_cos(function(x) { 1/ (x * x + 1) }, omega = 1)
```

---

owens_t *Owens T Function*

Description

Computes the Owens T function of h and a, giving the probability of the event (X > h and 0 < Y < a * X) where X and Y are independent standard normal random variables.

Usage

```
owens_t(h, a)
```

Arguments

h	The first argument of the Owens T function
a	The second argument of the Owens T function

Value

The value of the Owens T function at (h, a).

See Also

Boost Documentation for more details on the mathematical background.

Examples

```
# Owens T Function
owens_t(1, 0.5)
```

`pareto_distribution` *Pareto Distribution Functions*

Description

Functions to compute the probability density function, cumulative distribution function, and quantile function for the Pareto distribution.

Usage

```
pareto_pdf(x, shape = 1, scale = 1)

pareto_lpdf(x, shape = 1, scale = 1)

pareto_cdf(x, shape = 1, scale = 1)

pareto_lcdf(x, shape = 1, scale = 1)

pareto_quantile(p, shape = 1, scale = 1)
```

Arguments

`x`	quantile
`shape`	shape parameter (default is 1)
`scale`	scale parameter (default is 1)
`p`	probability (0 <= p <= 1)

Value

A single numeric value with the computed probability density, log-probability density, cumulative distribution, log-cumulative distribution, or quantile depending on the function called.

See Also

Boost Documentation for more details on the mathematical background.

Examples

```
# Pareto distribution with shape = 1, scale = 1
pareto_pdf(1)
pareto_lpdf(1)
pareto_cdf(1)
pareto_lcdf(1)
pareto_quantile(0.5)
```

poisson_distribution *Poisson Distribution Functions*

Description

Functions to compute the probability density function, cumulative distribution function, and quantile function for the Poisson distribution.

Usage

```
poisson_pdf(x, lambda = 1)

poisson_lpdf(x, lambda = 1)

poisson_cdf(x, lambda = 1)

poisson_lcdf(x, lambda = 1)

poisson_quantile(p, lambda = 1)
```

Arguments

x	quantile
lambda	rate parameter (default is 1)
p	probability (0 <= p <= 1)

Value

A single numeric value with the computed probability density, log-probability density, cumulative distribution, log-cumulative distribution, or quantile depending on the function called.

See Also

Boost Documentation for more details on the mathematical background.

Examples

```
# Poisson distribution with lambda = 1
poisson_pdf(0, 1)
poisson_lpdf(0, 1)
poisson_cdf(0, 1)
poisson_lcdf(0, 1)
poisson_quantile(0.5, 1)
```

`polynomial_root_finding` *Polynomial Root-Finding*

Description

Functions for finding roots of polynomials of various degrees.

Usage

```
quadratic_roots(a, b, c)

cubic_roots(a, b, c, d)

cubic_root_residual(a, b, c, d, root)

cubic_root_condition_number(a, b, c, d, root)

quartic_roots(a, b, c, d, e)
```

Arguments

`a`	Coefficient of the polynomial term (e.g., for quadratic ax^2 + bx + c, a is the coefficient of x^2).
`b`	Coefficient of the linear term (e.g., for quadratic ax^2 + bx + c, b is the coefficient of x).
`c`	Constant term (e.g., for quadratic ax^2 + bx + c, c is the constant).
`d`	Coefficient of the cubic term (for cubic ax^3 + bx^2 + cx + d, d is the constant).
`root`	The root to evaluate the residual or condition number at.
`e`	Coefficient of the quartic term (for quartic ax^4 + bx^3 + cx^2 + dx + e, e is the constant).

Details

This package provides functions to find roots of quadratic, cubic, and quartic polynomials. The functions return the roots as numeric vectors.

Value

A numeric vector of the polynomial roots, residual, or condition number.

Examples

```
# Example of finding quadratic roots
quadratic_roots(1, -3, 2)
# Example of finding cubic roots
cubic_roots(1, -6, 11, -6)
# Example of finding quartic roots
quartic_roots(1, -10, 35, -50, 24)
# Example of finding cubic root residual
cubic_root_residual(1, -6, 11, -6, 1)
# Example of finding cubic root condition number
cubic_root_condition_number(1, -6, 11, -6, 1)
```

---

rayleigh_distribution *Rayleigh Distribution Functions*

Description

Functions to compute the probability density function, cumulative distribution function, and quantile function for the Rayleigh distribution.

Usage

```
rayleigh_pdf(x, scale = 1)

rayleigh_lpdf(x, scale = 1)

rayleigh_cdf(x, scale = 1)

rayleigh_lcdf(x, scale = 1)

rayleigh_quantile(p, scale = 1)
```

Arguments

x	quantile
scale	scale parameter (default is 1)
p	probability (0 <= p <= 1)

Value

A single numeric value with the computed probability density, log-probability density, cumulative distribution, log-cumulative distribution, or quantile depending on the function called.

See Also

Boost Documentation for more details on the mathematical background.

Examples

```
# Rayleigh distribution with scale = 1
rayleigh_pdf(1)
rayleigh_lpdf(1)
rayleigh_cdf(1)
rayleigh_lcdf(1)
rayleigh_quantile(0.5)
```

`rootfinding_and_minimisation`
Root-Finding and Minimisation Functions

Description

Functions for root-finding and minimisation using various algorithms.

Usage

```
bisect(
  f,
  lower,
  upper,
  digits = .Machine$double.digits,
  max_iter = .Machine$integer.max
)

bracket_and_solve_root(
  f,
  guess,
  factor,
  rising,
  digits = .Machine$double.digits,
  max_iter = .Machine$integer.max
)

toms748_solve(
  f,
  lower,
  upper,
  digits = .Machine$double.digits,
  max_iter = .Machine$integer.max
)

newton_raphson_iterate(
  f,
  guess,
  lower,
```

```
  upper,
  digits = .Machine$double.digits,
  max_iter = .Machine$integer.max
)

halley_iterate(
  f,
  guess,
  lower,
  upper,
  digits = .Machine$double.digits,
  max_iter = .Machine$integer.max
)

schroder_iterate(
  f,
  guess,
  lower,
  upper,
  digits = .Machine$double.digits,
  max_iter = .Machine$integer.max
)

brent_find_minima(
  f,
  lower,
  upper,
  digits = .Machine$double.digits,
  max_iter = .Machine$integer.max
)
```

Arguments

f	A function to find the root of or to minimise. It should take and return a single numeric value for root-finding, or a numeric vector for minimisation.
lower	The lower bound of the interval to search for the root or minimum.
upper	The upper bound of the interval to search for the root or minimum.
digits	The number of significant digits to which the root or minimum should be found. Defaults to double precision.
max_iter	The maximum number of iterations to perform. Defaults to the maximum integer value.
guess	A numeric value that is a guess for the root or minimum.
factor	Size of steps to take when searching for the root.
rising	If TRUE, the function is assumed to be rising, otherwise it is assumed to be falling.

Details

This package provides a set of functions for finding roots of equations and minimising functions using different numerical methods. The methods include bisection, bracket and solve, TOMS 748, Newton-Raphson, Halley's method, Schroder's method, and Brent's method. It also includes functions for finding roots of polynomials (quadratic, cubic, quartic) and computing minima.

Value

A list containing the root or minimum value, the value of the function at that point, and the number of iterations performed.

See Also

Boost Documentation for more details on the mathematical background.

Examples

```
f <- function(x) x^2 - 2
bisect(f, lower = 0, upper = 2)
bracket_and_solve_root(f, guess = 1, factor = 0.1, rising = TRUE)
toms748_solve(f, lower = 0, upper = 2)
f <- function(x) c(x^2 - 2, 2 * x)
newton_raphson_iterate(f, guess = 1, lower = 0, upper = 2)
f <- function(x) c(x^2 - 2, 2 * x, 2)
halley_iterate(f, guess = 1, lower = 0, upper = 2)
schroder_iterate(f, guess = 1, lower = 0, upper = 2)
f <- function(x) (x - 2)^2 + 1
brent_find_minima(f, lower = 0, upper = 4)
```

---

saspoint5_distribution

SαS Point5 Distribution Functions

Description

Functions to compute the probability density function, cumulative distribution function, and quantile function for the SαS Point5 distribution.

Usage

```
saspoint5_pdf(x, location = 0, scale = 1)

saspoint5_lpdf(x, location = 0, scale = 1)

saspoint5_cdf(x, location = 0, scale = 1)

saspoint5_lcdf(x, location = 0, scale = 1)

saspoint5_quantile(p, location = 0, scale = 1)
```

Arguments

x	quantile
location	location parameter (default is 0)
scale	scale parameter (default is 1)
p	probability (0 <= p <= 1)

Value

A single numeric value with the computed probability density, log-probability density, cumulative distribution, log-cumulative distribution, or quantile depending on the function called.

See Also

Boost Documentation for more details on the mathematical background.

Examples

```
# Distribution only available with Boost version 1.87.0 or later.
## Not run:
# SaS Point5 distribution with location 0 and scale 1
  saspoint5_pdf(3)
  saspoint5_lpdf(3)
  saspoint5_cdf(3)
  saspoint5_lcdf(3)
  saspoint5_quantile(0.5)

## End(Not run)
```

---

sinus_cardinal_hyperbolic_functions

Sinus Cardinal and Hyperbolic Functions

Description

Functions to compute the sinus cardinal function and hyperbolic sinus cardinal function.

Usage

```
sinc_pi(x)

sinhc_pi(x)
```

Arguments

x	Input value

Value

A single numeric value with the computed sinus cardinal or hyperbolic sinus cardinal function.

See Also

Boost Documentation for more details on the mathematical background.

Examples

```
# Sinus cardinal function
sinc_pi(0.5)
# Hyperbolic sinus cardinal function
sinhc_pi(0.5)
```

---

skew_normal_distribution

Skew Normal Distribution Functions

Description

Functions to compute the probability density function, cumulative distribution function, and quantile function for the Skew Normal distribution.

Usage

```
skew_normal_pdf(x, location = 0, scale = 1, shape = 0)

skew_normal_lpdf(x, location = 0, scale = 1, shape = 0)

skew_normal_cdf(x, location = 0, scale = 1, shape = 0)

skew_normal_lcdf(x, location = 0, scale = 1, shape = 0)

skew_normal_quantile(p, location = 0, scale = 1, shape = 0)
```

Arguments

x	quantile
location	location parameter (default is 0)
scale	scale parameter (default is 1)
shape	shape parameter (default is 0)
p	probability (0 <= p <= 1)

Value

A single numeric value with the computed probability density, log-probability density, cumulative distribution, log-cumulative distribution, or quantile depending on the function called.

See Also

Boost Documentation for more details on the mathematical background.

Examples

```
# Skew Normal distribution with location = 0, scale = 1, shape = 0
skew_normal_pdf(0)
skew_normal_lpdf(0)
skew_normal_cdf(0)
skew_normal_lcdf(0)
skew_normal_quantile(0.5)
```

---

spherical_harmonics *Spherical Harmonics*

Description

Functions to compute spherical harmonics and related functions.

Usage

```
spherical_harmonic(n, m, theta, phi)

spherical_harmonic_r(n, m, theta, phi)

spherical_harmonic_i(n, m, theta, phi)
```

Arguments

n	Degree of the spherical harmonic
m	Order of the spherical harmonic
theta	Polar angle (colatitude)
phi	Azimuthal angle (longitude)

Value

A single complex value with the computed spherical harmonic function, or its real and imaginary parts.

See Also

Boost Documentation

Examples

```
# Spherical harmonic function Y_2^1(0.5, 0.5)
spherical_harmonic(2, 1, 0.5, 0.5)
# Real part of the spherical harmonic function Y_2^1(0.5, 0.5)
spherical_harmonic_r(2, 1, 0.5, 0.5)
# Imaginary part of the spherical harmonic function Y_2^1(0.5, 0.5)
spherical_harmonic_i(2, 1, 0.5, 0.5)
```

`students_t_distribution`

Student's T Distribution Functions

Description

Functions to compute the probability density function, cumulative distribution function, and quantile function for the Student's t distribution.

Usage

```
students_t_pdf(x, df = 1)

students_t_lpdf(x, df = 1)

students_t_cdf(x, df = 1)

students_t_lcdf(x, df = 1)

students_t_quantile(p, df = 1)
```

Arguments

`x`	quantile
`df`	degrees of freedom (default is 1)
`p`	probability (0 <= p <= 1)

Value

A single numeric value with the computed probability density, log-probability density, cumulative distribution, log-cumulative distribution, or quantile depending on the function called.

See Also

Boost Documentation for more details on the mathematical background.

Examples

```
# Student's t distribution with 3 degrees of freedom
students_t_pdf(0, 3)
students_t_lpdf(0, 3)
students_t_cdf(0, 3)
students_t_lcdf(0, 3)
students_t_quantile(0.5, 3)
```

`triangular_distribution`

Triangular Distribution Functions

Description

Functions to compute the probability density function, cumulative distribution function, and quantile function for the Triangular distribution.

Usage

```
triangular_pdf(x, lower = 0, mode = 1, upper = 2)

triangular_lpdf(x, lower = 0, mode = 1, upper = 2)

triangular_cdf(x, lower = 0, mode = 1, upper = 2)

triangular_lcdf(x, lower = 0, mode = 1, upper = 2)

triangular_quantile(p, lower = 0, mode = 1, upper = 2)
```

Arguments

`x`	quantile
`lower`	lower limit of the distribution (default is 0)
`mode`	mode of the distribution (default is 1)
`upper`	upper limit of the distribution (default is 2)
`p`	probability (0 <= p <= 1)

Value

A single numeric value with the computed probability density, log-probability density, cumulative distribution, log-cumulative distribution, or quantile depending on the function called.

See Also

Boost Documentation for more details on the mathematical background.

Examples

```
# Triangular distribution with lower = 0, mode = 1, upper = 2
triangular_pdf(1)
triangular_lpdf(1)
triangular_cdf(1)
triangular_lcdf(1)
triangular_quantile(0.5)
```

`uniform_distribution` *Uniform Distribution Functions*

Description

Functions to compute the probability density function, cumulative distribution function, and quantile function for the Uniform distribution.

Usage

```
uniform_pdf(x, lower = 0, upper = 1)

uniform_lpdf(x, lower = 0, upper = 1)

uniform_cdf(x, lower = 0, upper = 1)

uniform_lcdf(x, lower = 0, upper = 1)

uniform_quantile(p, lower = 0, upper = 1)
```

Arguments

`x`	quantile
`lower`	lower bound of the distribution (default is 0)
`upper`	upper bound of the distribution (default is 1)
`p`	probability (0 <= p <= 1)

Value

A single numeric value with the computed probability density, log-probability density, cumulative distribution, log-cumulative distribution, or quantile depending on the function called.

See Also

Boost Documentation for more details on the mathematical background.

Examples

```
# Uniform distribution with lower = 0, upper = 1
uniform_pdf(0.5)
uniform_lpdf(0.5)
uniform_cdf(0.5)
uniform_lcdf(0.5)
uniform_quantile(0.5)
```

`vector_functionals` *Vector Functionals*

Description

Functions to compute various vector norms and distances.

Usage

```
l0_pseudo_norm(x)

hamming_distance(x, y)

l1_norm(x)

l1_distance(x, y)

l2_norm(x)

l2_distance(x, y)

sup_norm(x)

sup_distance(x, y)

lp_norm(x, p)

lp_distance(x, y, p)

total_variation(x)
```

Arguments

x	A numeric vector.
y	A numeric vector of the same length as x (for distance functions).
p	A positive integer indicating the order of the norm or distance (for Lp functions).

Value

A single numeric value with the computed norm or distance.

See Also

Boost Documentation for more details on the mathematical background.

Examples

```
# L0 Pseudo Norm
l0_pseudo_norm(c(1, 0, 2, 0, 3))
# Hamming Distance
hamming_distance(c(1, 0, 1), c(0, 1, 1))
# L1 Norm
l1_norm(c(1, -2, 3))
# L1 Distance
l1_distance(c(1, -2, 3), c(4, -5, 6))
# L2 Norm
l2_norm(c(3, 4))
# L2 Distance
l2_distance(c(3, 4), c(0, 0))
# Supremum Norm
sup_norm(c(1, -2, 3))
# Supremum Distance
sup_distance(c(1, -2, 3), c(4, -5, 6))
# Lp Norm
lp_norm(c(1, -2, 3), 3)
# Lp Distance
lp_distance(c(1, -2, 3), c(4, -5, 6), 3)
# Total Variation
total_variation(c(1, 2, 1, 3))
```

---

weibull_distribution *Weibull Distribution Functions*

Description

Functions to compute the probability density function, cumulative distribution function, and quantile function for the Weibull distribution.

Usage

```
weibull_pdf(x, shape = 1, scale = 1)

weibull_lpdf(x, shape = 1, scale = 1)

weibull_cdf(x, shape = 1, scale = 1)

weibull_lcdf(x, shape = 1, scale = 1)

weibull_quantile(p, shape = 1, scale = 1)
```

Arguments

x	quantile
shape	shape parameter (default is 1)
scale	scale parameter (default is 1)
p	probability (0 <= p <= 1)

Value

A single numeric value with the computed probability density, log-probability density, cumulative distribution, log-cumulative distribution, or quantile depending on the function called.

See Also

Boost Documentation for more details on the mathematical background.

Examples

```
# Weibull distribution with shape = 1, scale = 1
weibull_pdf(1)
weibull_lpdf(1)
weibull_cdf(1)
weibull_lcdf(1)
weibull_quantile(0.5)
```

---

zeta *Riemann Zeta Function*

Description

Computes the Riemann zeta function ($\zeta(s)$) for argument (z).

Usage

```
zeta(z)
```

Arguments

z	Real number input

Value

The value of the Riemann zeta function ($\zeta(z)$).

Examples

```
# Riemann Zeta Function
zeta(2)  # Should return pi^2 / 6
```

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