

# Package ‘shannon’

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**Type** Package

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**Description** The functions allow for the numerical evaluation of some commonly used entropy measures, such as Shannon entropy, Rényi entropy, Havrda and Charvat entropy, and Arimoto entropy, at selected parametric values from several well-known and widely used probability distributions. Moreover, the functions also compute the relative loss of these entropies using the truncated distributions. Related works include: Awad, A. M., & Alawneh, A. J. (1987). Application of entropy to a life-time model. *IMA Journal of Mathematical Control and Information*, 4(2), 143-148. <doi:10.1093/imamci/4.2.143>.

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## Description

The functions allow for the numerical evaluation of some commonly used entropy measures, such as Shannon entropy, Rényi entropy, Havrda and Charvat entropy, and Arimoto entropy, at selected parametric values from several well-known and widely used probability distributions. Moreover, the functions also compute the relative loss of these entropies using the truncated distributions. Let  $X$  be an absolutely continuous random variable having the probability density function  $f(x)$ . Then, the Shannon entropy is as follows:

$$H(X) = - \int_{-\infty}^{+\infty} f(x) \log f(x) dx.$$

The Rényi entropy is as follows:

$$H_{\delta}(X) = \frac{1}{1-\delta} \log \int_{-\infty}^{+\infty} f(x)^{\delta} dx; \quad \delta > 0, \delta \neq 1.$$

The Havrda and Charvat entropy is as follows:

$$H_{\delta}(X) = \frac{1}{2^{1-\delta} - 1} \left( \int_{-\infty}^{+\infty} f(x)^{\delta} dx - 1 \right); \quad \delta > 0, \delta \neq 1.$$

The Arimoto entropy is as follows:

$$H_{\delta}(X) = \frac{\delta}{1-\delta} \left[ \left( \int_{-\infty}^{+\infty} f(x)^{\delta} dx \right)^{\frac{1}{\delta}} - 1 \right]; \quad \delta > 0, \delta \neq 1.$$

Let  $D(X)$  be an entropy, and  $D_p(X)$  be its truncated integral version at  $p$ , i.e., defined with the truncated version of  $f(x)$  over the interval  $(-\infty, p)$ . Then we define the corresponding relative loss entropy is defined by

$$S_D(p) = \frac{D(X) - D_p(X)}{D(X)}.$$

## Details

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### References

Shannon, C. E. (1948). A mathematical theory of communication. The Bell system technical journal, 27(3), 379-423.

Rényi, A. (1961). On measures of entropy and information, Hungarian Academy of Sciences, Budapest, Hungary, 547- 561.

Havrda, J., & Charvat, F. (1967). Quantification method of classification processes. Concept of structural  $\alpha$ -entropy. Kybernetika, 3(1), 30-35.

Arimoto, S. (1971). Information-theoretical considerations on estimation problems. Information and control, 19(3), 181-194.

Awad, A. M., & Alawneh, A. J. (1987). Application of entropy to a life-time model. IMA Journal of Mathematical Control and Information, 4(2), 143-148.

---

Beta distribution      *Compute the Shannon, Rényi, Havrda and Charvat, and Arimoto entropies of the beta distribution*

---

### Description

Compute the Shannon, Rényi, Havrda and Charvat, and Arimoto entropies of the beta distribution.

### Usage

```
Se_beta(alpha, beta)
re_beta(alpha, beta, delta)
hce_beta(alpha, beta, delta)
ae_beta(alpha, beta, delta)
```

**Arguments**

alpha	The strictly positive shape parameter of the beta distribution ( $\alpha > 0$ ).
beta	The strictly positive shape parameter of the beta distribution ( $\beta > 0$ ).
delta	The strictly positive parameter ( $\delta > 0$ ) and ( $\delta \neq 1$ ).

**Details**

The following is the probability density function of the beta distribution:

$$f(x) = \frac{\Gamma(\alpha + \beta)}{\Gamma(\alpha)\Gamma(\beta)} x^{\alpha-1} (1-x)^{\beta-1},$$

where  $0 \leq x \leq 1$ ,  $\alpha > 0$  and  $\beta > 0$ , and  $\Gamma(a)$  denotes the standard gamma function.

**Value**

The functions `Se_beta`, `re_beta`, `hce_beta`, and `ae_beta` provide the Shannon entropy, Rényi entropy, Havrda and Charvat entropy, and Arimoto entropy, respectively, depending on the selected parametric values of the beta distribution and  $\delta$ .

**Author(s)**

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**References**

Gupta, A. K., & Nadarajah, S. (2004). Handbook of beta distribution and its applications. CRC Press.

Johnson, N. L., Kotz, S., & Balakrishnan, N. (1994). Beta distributions. Continuous univariate distributions. 2nd ed. New York, NY: John Wiley and Sons, 221-235.

**See Also**

[se\\_kum](#), [re\\_kum](#), [hce\\_kum](#), [ae\\_kum](#)

**Examples**

```
# Computation of the Shannon entropy
Se_beta(2, 4)
delta <- c(1.2, 3)
# Computation of the Rényi entropy
re_beta(2, 4, delta)
# Computation of the Havrda and Charvat entropy
hce_beta(2, 4, delta)
# Computation of the Arimoto entropy
ae_beta(2, 4, delta)
# A graphic presentation of the Havrda and Charvat entropy (HCE)
```

```

library(ggplot2)
delta <- c(0.2, 0.3, 0.5, 0.8, 1.2, 1.5, 2.5, 3, 3.5)
hce_beta(2, 1.2, delta)
z <- hce_beta(2, 1.2, delta)
dat <- data.frame(x = delta , HCE = z)
p_hce <- ggplot(dat, aes(x = delta, y = HCE)) + geom_line()
plot <- p_hce + ggtitle(expression(alpha == 2~beta == 1.2))

```

---

## Beta exponential distribution

*Compute the Shannon, Rényi, Havrda and Charvat, and Arimoto entropies of the beta exponential distribution*

---

### Description

Compute the Shannon, Rényi, Havrda and Charvat, and Arimoto entropies of the beta exponential distribution.

### Usage

```

se_bexp(lambda, alpha, beta)
re_bexp(lambda, alpha, beta, delta)
hce_bexp(lambda, alpha, beta, delta)
ae_bexp(lambda, alpha, beta, delta)

```

### Arguments

lambda	The strictly positive scale parameter of the exponential distribution ( $\lambda > 0$ ).
alpha	The strictly positive shape parameter of the beta distribution ( $\alpha > 0$ ).
beta	The strictly positive shape parameter of the beta distribution ( $\beta > 0$ ).
delta	The strictly positive parameter ( $\delta > 0$ ) and ( $\delta \neq 1$ ).

### Details

The following is the probability density function of the beta exponential distribution:

$$f(x) = \frac{\lambda e^{-\beta \lambda x}}{B(\alpha, \beta)} (1 - e^{-\lambda x})^{\alpha-1},$$

where  $x > 0$ ,  $\alpha > 0$ ,  $\beta > 0$  and  $\lambda > 0$ , and  $B(a, b)$  denotes the standard beta function.

### Value

The functions `se_bexp`, `re_bexp`, `hce_bexp`, and `ae_bexp` provide the Shannon entropy, Rényi entropy, Havrda and Charvat entropy, and Arimoto entropy, respectively, depending on the selected parametric values of the beta exponential distribution and  $\delta$ .

**Author(s)**

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**References**

Nadarajah, S., & Kotz, S. (2006). The beta exponential distribution. *Reliability Engineering & System Safety*, 91(6), 689-697.

**See Also**

[re\\_beta](#), [re\\_exp](#)

**Examples**

```
# Computation of the Shannon entropy
se_bexp(1.2, 0.2, 1.5)
delta <- c(0.2, 0.3, 0.5)
# Computation of the Rényi entropy
re_bexp(1.2, 0.2, 0.5, delta)
# Computation of the Havrda and Charvat entropy
hce_bexp(1.2, 0.2, 1.5, delta)
# Computation of the Arimoto entropy
ae_bexp(1.2, 0.2, 1.5, delta)
```

---

Birnbaum-Saunders distribution

*Compute the Shannon, Rényi, Havrda and Charvat, and Arimoto entropies of the Birnbaum-Saunders distribution*

---

**Description**

Compute the Shannon, Rényi, Havrda and Charvat, and Arimoto entropies of the Birnbaum-Saunders distribution.

**Usage**

```
se_bs(v)
re_bs(v, delta)
hce_bs(v, delta)
ae_bs(v, delta)
```

**Arguments**

**v** The strictly positive scale parameter of the Birnbaum-Saunders distribution ( $v > 0$ ).

**delta** The strictly positive parameter ( $\delta > 0$ ) and ( $\delta \neq 1$ ).

**Details**

The following is the probability density function of the Birnbaum-Saunders distribution:

$$f(x) = \frac{x^{0.5} + x^{-0.5}}{2vx} \phi\left(\frac{x^{0.5} - x^{-0.5}}{v}\right),$$

where  $x > 0$  and  $v > 0$ , and  $\phi(x)$  is the probability density function of the standard normal distribution.

**Value**

The functions `se_bs`, `re_bs`, `hce_bs`, and `ae_bs` provide the Shannon entropy, Rényi entropy, Havrda and Charvat entropy, and Arimoto entropy, respectively, depending on the selected parametric values of the Birnbaum-Saunders distribution and  $\delta$ .

**Author(s)**

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R implementation and documentation: Muhammad Imran <imranshako0r84@yahoo.com>, Christophe Chesneau <christophe.chesneau@unicaen.fr> and Farrukh Jamal <farrukh.jamal@iub.edu.pk>.

**References**

Chan, S., Nadarajah, S., & Afuecheta, E. (2016). An R package for value at risk and expected shortfall. *Communications in Statistics Simulation and Computation*, 45(9), 3416-3434.

Arimoto, S. (1971). Information-theoretical considerations on estimation problems. *Inf. Control*, 19, 181-194.

**See Also**

[re\\_exp](#), [re\\_chi](#)

**Examples**

```
se_bs(0.2)
delta <- c(1.5, 2, 3)
re_bs(0.2, delta)
hce_bs(0.2, delta)
ae_bs(0.2, delta)
```

---

Burr XII distribution *Compute the Shannon, Rényi, Havrda and Charvat, and Arimoto entropies of the Burr XII distribution*

---

### Description

Compute the Shannon, Rényi, Havrda and Charvat, and Arimoto entropies of the Burr XII distribution.

### Usage

```
se_burr(k, c)
re_burr(k, c, delta)
hce_burr(k, c, delta)
ae_burr(k, c, delta)
```

### Arguments

k	The strictly positive shape parameter of the Burr XII distribution ( $k > 0$ ).
c	The strictly positive shape parameter of the Burr XII distribution ( $c > 0$ ).
delta	The strictly positive parameter ( $\delta > 0$ ) and ( $\delta \neq 1$ ).

### Details

The following is the probability density function of the Burr XII distribution:

$$f(x) = kcx^{c-1} (1 + x^c)^{-k-1},$$

where  $x > 0$ ,  $c > 0$  and  $k > 0$ .

### Value

The functions `se_burr`, `re_burr`, `hce_burr`, and `ae_burr` provide the Shannon entropy, Rényi entropy, Havrda and Charvat entropy, and Arimoto entropy, respectively, depending on the selected parametric values of the Burr XII distribution and  $\delta$ .

### Author(s)

Muhammad Imran, Christophe Chesneau and Farrukh Jamal

R implementation and documentation: Muhammad Imran <imranshakoor84@yahoo.com>, Christophe Chesneau <christophe.chesneau@unicaen.fr> and Farrukh Jamal <farrukh.jamal@iub.edu.pk>.

### References

Rodriguez, R. N. (1977). A guide to the Burr type XII distributions. *Biometrika*, 64(1), 129-134.  
 Zimmer, W. J., Keats, J. B., & Wang, F. K. (1998). The Burr XII distribution in reliability analysis. *Journal of Quality Technology*, 30(4), 386-394.

**See Also**

[re\\_gamma](#), [re\\_wei](#)

**Examples**

```
se_burr(0.2, 1.4)
delta <- c(2, 3)
re_burr(1.2, 1.4, delta)
hce_burr(1.2, 1.4, delta)
ae_burr(1.2, 1.4, delta)
```

---

Chi-squared distribution

*Compute the Shannon, Rényi, Havrda and Charvat, and Arimoto entropies of the Chi-squared distribution*

---

**Description**

Compute the Shannon, Rényi, Havrda and Charvat, and Arimoto entropies of the chi-squared distribution.

**Usage**

```
se_chi(n)
re_chi(n, delta)
hce_chi(n, delta)
ae_chi(n, delta)
```

**Arguments**

n	The degree of freedom and the positive parameter of the Chi-squared distribution ( $n > 0$ ).
delta	The strictly positive parameter ( $\delta > 0$ ) and ( $\delta \neq 1$ ).

**Details**

The following is the probability density function of the (non-central) Chi-squared distribution:

$$f(x) = \frac{1}{2^{\frac{n}{2}} \Gamma(\frac{n}{2})} x^{\frac{n}{2}-1} e^{-\frac{x}{2}},$$

where  $x > 0$  and  $n > 0$ , and  $\Gamma(a)$  denotes the standard gamma function.

**Value**

The functions `se_chi`, `re_chi`, `hce_chi`, and `ae_chi` provide the Shannon entropy, Rényi entropy, Havrda and Charvat entropy, and Arimoto entropy, respectively, depending on the selected parametric values of the Chi-squared distribution and  $\delta$ .

**Author(s)**

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R implementation and documentation: Muhammad Imran <imranshakoor84@yahoo.com>, Christophe Chesneau <christophe.chesneau@unicaen.fr> and Farrukh Jamal <farrukh.jamal@iub.edu.pk>.

**References**

Johnson, N. L., Kotz, S., & Balakrishnan, N. (1995). Continuous univariate distributions, volume 2 (Vol. 289). John Wiley & Sons.

**See Also**

[re\\_exp](#), [re\\_gamma](#), [re\\_bs](#)

**Examples**

```
se_chi(1.2)
delta <- c(0.2, 0.3)
re_chi(1.2, delta)
hce_chi(1.2, delta)
ae_chi(1.2, delta)
```

---

Exponential distribution

*Compute the Shannon, Rényi, Havrda and Charvat, and Arimoto entropies of the exponential distribution*

---

**Description**

Compute the Shannon, Rényi, Havrda and Charvat, and Arimoto entropies of the exponential distribution.

**Usage**

```
Se_exp(alpha)
re_exp(alpha, delta)
hce_exp(alpha, delta)
ae_exp(alpha, delta)
```

**Arguments**

alpha            The strictly positive scale parameter of the exponential distribution ( $\alpha > 0$ ).

delta            The strictly positive parameter ( $\delta > 0$ ) and ( $\delta \neq 1$ ).

**Details**

The following is the probability density function of the exponential distribution:

$$f(x) = \alpha e^{-\alpha x},$$

where  $x > 0$  and  $\alpha > 0$ .

**Value**

The functions `Se_exp`, `re_exp`, `hce_exp`, and `ae_exp` provide the Shannon entropy, Rényi entropy, Havrda and Charvat entropy, and Arimoto entropy, respectively, depending on the selected parametric values of the exponential distribution and  $\delta$ .

**Author(s)**

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R implementation and documentation: Muhammad Imran <imranshako0r84@yahoo.com>, Christophe Chesneau <christophe.chesneau@unicaen.fr> and Farrukh Jamal <farrukh.jamal@iub.edu.pk>.

**References**

Balakrishnan, K. (2019). Exponential distribution: theory, methods and applications. Routledge.

Singh, A. K. (1997). The exponential distribution-theory, methods and applications, *Technometrics*, 39(3), 341-341.

Arimoto, S. (1971). Information-theoretical considerations on estimation problems. *Inf. Control*, 19, 181–194.

**See Also**

[re\\_chi](#), [re\\_gamma](#), [re\\_wei](#)

**Examples**

```
Se_exp(0.2)
delta <- c(1.5, 2, 3)
re_exp(0.2, delta)
hce_exp(0.2, delta)
ae_exp(0.2, delta)
```

---

Exponential extension distribution

*Compute the Shannon, Rényi, Havrda and Charvat, and Arimoto entropies of the exponential extension distribution*

---

### Description

Compute the Shannon, Rényi, Havrda and Charvat, and Arimoto entropies of the exponential extension distribution.

### Usage

```
se_nh(alpha, beta)
re_nh(alpha, beta, delta)
hce_nh(alpha, beta, delta)
ae_nh(alpha, beta, delta)
```

### Arguments

alpha	The strictly positive parameter of the exponential extension distribution ( $\alpha > 0$ ).
beta	The strictly positive parameter of the exponential extension distribution ( $\beta > 0$ ).
delta	The strictly positive parameter ( $\delta > 0$ ) and ( $\delta \neq 1$ ).

### Details

The following is the probability density function of the exponential extension distribution:

$$f(x) = \alpha\beta(1 + \alpha x)^{\beta-1}e^{1-(1+\alpha x)^\beta},$$

where  $x > 0$ ,  $\alpha > 0$  and  $\beta > 0$ .

### Value

The functions `se_nh`, `re_nh`, `hce_nh`, and `ae_nh` provide the Shannon entropy, Rényi entropy, Havrda and Charvat entropy, and Arimoto entropy, respectively, depending on the selected parametric values of the exponential extension distribution and  $\delta$ .

### Author(s)

Muhammad Imran, Christophe Chesneau and Farrukh Jamal

R implementation and documentation: Muhammad Imran <imranshakoor84@yahoo.com>, Christophe Chesneau <christophe.chesneau@unicaen.fr> and Farrukh Jamal <farrukh.jamal@iub.edu.pk>.

### References

Nadarajah, S., & Haghghi, F. (2011). An extension of the exponential distribution. *Statistics*, 45(6), 543-558.

**See Also**

[re\\_exp](#), [re\\_gamma](#), [re\\_ee](#), [re\\_wei](#)

**Examples**

```
se_nh(1.2, 0.2)
delta <- c(1.5, 2, 3)
re_nh(1.2, 0.2, delta)
hce_nh(1.2, 0.2, delta)
ae_nh(1.2, 0.2, delta)
```

---

Exponentiated exponential distribution

*Compute the Shannon, Rényi, Havrda and Charvat, and Arimoto entropies of the exponentiated exponential distribution*

---

**Description**

Compute the Shannon, Rényi, Havrda and Charvat, and Arimoto entropies of the exponentiated exponential distribution.

**Usage**

```
se_ee(alpha, beta)
re_ee(alpha, beta, delta)
hce_ee(alpha, beta, delta)
ae_ee(alpha, beta, delta)
```

**Arguments**

alpha	The strictly positive scale parameter of the exponentiated exponential distribution ( $\alpha > 0$ ).
beta	The strictly positive shape parameter of the exponentiated exponential distribution ( $\beta > 0$ ).
delta	The strictly positive parameter ( $\delta > 0$ ) and ( $\delta \neq 1$ ).

**Details**

The following is the probability density function of the exponentiated exponential distribution:

$$f(x) = \alpha\beta e^{-\alpha x} (1 - e^{-\alpha x})^{\beta-1},$$

where  $x > 0$ ,  $\alpha > 0$  and  $\beta > 0$ .

**Value**

The functions `se_ee`, `re_ee`, `hce_ee`, and `ae_ee` provide the Shannon entropy, Rényi entropy, Havrda and Charvat entropy, and Arimoto entropy, respectively, depending on the selected parametric values of the exponentiated exponential distribution and  $\delta$ .

**Author(s)**

Muhammad Imran, Christophe Chesneau and Farrukh Jamal

R implementation and documentation: Muhammad Imran <imranshako0r84@yahoo.com>, Christophe Chesneau <christophe.chesneau@unicaen.fr> and Farrukh Jamal <farrukh.jamal@iub.edu.pk>.

**References**

Nadarajah, S. (2011). The exponentiated exponential distribution: a survey. *AStA Advances in Statistical Analysis*, 95, 219-251.

Gupta, R. D., & Kundu, D. (2007). Generalized exponential distribution: Existing results and some recent developments. *Journal of Statistical Planning and Inference*, 137(11), 3537-3547.

**See Also**

[re\\_exp](#), [re\\_wei](#), [re\\_nh](#)

**Examples**

```
se_ee(0.2, 1.4)
delta <- c(1.5, 2, 3)
re_ee(0.2, 1.4, delta)
hce_ee(0.2, 1.4, delta)
ae_ee(0.2, 1.4, delta)
```

---

Exponentiated Weibull distribution

*Compute the Shannon, Rényi, Havrda and Charvat, and Arimoto entropies of the exponentiated Weibull distribution*

---

**Description**

Compute the Shannon, Rényi, Havrda and Charvat, and Arimoto entropies of the exponentiated Weibull distribution.

**Usage**

```
se_ew(a, beta, zeta)
re_ew(a, beta, zeta, delta)
hce_ew(a, beta, zeta, delta)
ae_ew(a, beta, zeta, delta)
```

**Arguments**

a	The strictly positive shape parameter of the exponentiated Weibull distribution ( $a > 0$ ).
beta	The strictly positive scale parameter of the baseline Weibull distribution ( $\beta > 0$ ).
zeta	The strictly positive shape parameter of the baseline Weibull distribution ( $\zeta > 0$ ).
delta	The strictly positive parameter ( $\delta > 0$ ) and ( $\delta \neq 1$ ).

**Details**

The following is the probability density function of the exponentiated Weibull distribution:

$$f(x) = a\zeta\beta^{-\zeta}x^{\zeta-1}e^{-\left(\frac{x}{\beta}\right)^\zeta} \left[1 - e^{-\left(\frac{x}{\beta}\right)^\zeta}\right]^{a-1},$$

where  $x > 0$ ,  $a > 0$ ,  $\beta > 0$  and  $\zeta > 0$ .

**Value**

The functions `se_ew`, `re_ew`, `hce_ew`, and `ae_ew` provide the Shannon entropy, Rényi entropy, Havrda and Charvat entropy, and Arimoto entropy, respectively, depending on the selected parametric values of the exponentiated Weibull distribution and  $\delta$ .

**Author(s)**

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R implementation and documentation: Muhammad Imran <imranshakoor84@yahoo.com>, Christophe Chesneau <christophe.chesneau@unicaen.fr> and Farrukh Jamal <farrukh.jamal@iub.edu.pk>.

**References**

Nadarajah, S., Cordeiro, G. M., & Ortega, E. M. (2013). The exponentiated Weibull distribution: a survey. *Statistical Papers*, 54, 839-877.

**See Also**

[re\\_exp](#), [re\\_wei](#), [re\\_ew](#)

**Examples**

```
se_ew(0.8, 0.2, 0.8)
delta <- c(1.5, 2, 3)
re_ew(1.2, 1.2, 1.4, delta)
hce_ew(1.2, 1.2, 1.4, delta)
ae_ew(1.2, 1.2, 1.4, delta)
```

---

F distribution	<i>Compute the Shannon, Rényi, Havrda and Charvat, and Arimoto entropies of the F distribution</i>
----------------	--

---

**Description**

Compute the Shannon, Rényi, Havrda and Charvat, and Arimoto entropies of the F distribution.

**Usage**

```
se_f(alpha, beta)
re_f(alpha, beta, delta)
hce_f(alpha, beta, delta)
ae_f(alpha, beta, delta)
```

**Arguments**

alpha	The strictly positive parameter (first degree of freedom) of the F distribution ( $\alpha > 0$ ).
beta	The strictly positive parameter (second degree of freedom) of the F distribution ( $\beta > 0$ ).
delta	The strictly positive parameter ( $\delta > 0$ ) and ( $\delta \neq 1$ ).

**Details**

The following is the probability density function of the F distribution:

$$f(x) = \frac{1}{B\left(\frac{\alpha}{2}, \frac{\beta}{2}\right)} \left(\frac{\alpha}{\beta}\right)^{\frac{\alpha}{2}} x^{\frac{\alpha}{2}-1} \left(1 + \frac{\alpha}{\beta}x\right)^{-\left(\frac{\alpha+\beta}{2}\right)},$$

where  $x > 0$ ,  $\alpha > 0$  and  $\beta > 0$ , and  $B(a, b)$  is the standard beta function.

**Value**

The functions `se_f`, `re_f`, `hce_f`, and `ae_f` provide the Shannon entropy, Rényi entropy, Havrda and Charvat entropy, and Arimoto entropy, respectively, depending on the selected parametric values of the F distribution and  $\delta$ .

**Author(s)**

Muhammad Imran, Christophe Chesneau and Farrukh Jamal

R implementation and documentation: Muhammad Imran <imranshakoor84@yahoo.com>, Christophe Chesneau <christophe.chesneau@unicaen.fr> and Farrukh Jamal <farrukh.jamal@iub.edu.pk>.

**References**

Johnson, N. L., Kotz, S., & Balakrishnan, N. (1995). Continuous univariate distributions, volume 2 (Vol. 289). John Wiley & Sons.

**See Also**

[re\\_exp](#), [re\\_gamma](#)

**Examples**

```
se_f(1.2, 1.4)
delta <- c(2.2, 2.3)
re_f(1.2, 0.4, delta)
hce_f(1.2, 1.4, delta)
ae_f(1.2, 1.4, delta)
```

---

Fréchet distribution    *Compute the Shannon, Rényi, Havrda and Charvat, and Arimoto entropies of the Fréchet distribution*

---

**Description**

Compute the Shannon, Rényi, Havrda and Charvat, and Arimoto entropies of the Fréchet distribution.

**Usage**

```
se_fre(alpha, beta, zeta)
re_fre(alpha, beta, zeta, delta)
hce_fre(alpha, beta, zeta, delta)
ae_fre(alpha, beta, zeta, delta)
```

**Arguments**

alpha	The parameter of the Fréchet distribution ( $\alpha > 0$ ).
beta	The parameter of the Fréchet distribution ( $\beta \in (-\infty, +\infty)$ ).
zeta	The parameter of the Fréchet distribution ( $\zeta > 0$ ).
delta	The strictly positive parameter ( $\delta > 0$ ) and ( $\delta \neq 1$ ).

**Details**

The following is the probability density function of the Fréchet distribution:

$$f(x) = \frac{\alpha}{\zeta} \left( \frac{x - \beta}{\zeta} \right)^{-1-\alpha} e^{-\left(\frac{x-\beta}{\zeta}\right)^{-\alpha}},$$

where  $x > \beta$ ,  $\alpha > 0$ ,  $\zeta > 0$  and  $\beta \in (-\infty, +\infty)$ . The Fréchet distribution is also known as inverse Weibull distribution and special case of the generalized extreme value distribution.

**Value**

The functions `se_fre`, `re_fre`, `hce_fre`, and `ae_fre` provide the Shannon entropy, Rényi entropy, Havrda and Charvat entropy, and Arimoto entropy, respectively, depending on the selected parametric values of the Fréchet distribution and  $\delta$ .

**Author(s)**

Muhammad Imran, Christophe Chesneau and Farrukh Jamal

R implementation and documentation: Muhammad Imran <imranshako0r84@yahoo.com>, Christophe Chesneau <christophe.chesneau@unicaen.fr> and Farrukh Jamal <farrukh.jamal@iub.edu.pk>.

**References**

Abbas, K., & Tang, Y. (2015). Analysis of Fréchet distribution using reference priors. *Communications in Statistics-Theory and Methods*, 44(14), 2945-2956.

**See Also**

[re\\_exp](#), [re\\_gum](#)

**Examples**

```
se_fre(0.2, 1.4, 1.2)
delta <- c(2, 3)
re_fre(1.2, 0.4, 1.2, delta)
hce_fre(1.2, 0.4, 1.2, delta)
ae_fre(1.2, 0.4, 1.2, delta)
```

---

Gamma distribution	<i>Compute the Shannon, Rényi, Havrda and Charvat, and Arimoto entropies of the gamma distribution</i>
--------------------	--

---

**Description**

Compute the Shannon, Rényi, Havrda and Charvat, and Arimoto entropies of the gamma distribution.

**Usage**

```
Se_gamma(alpha, beta)
re_gamma(alpha, beta, delta)
hce_gamma(alpha, beta, delta)
ae_gamma(alpha, beta, delta)
```

**Arguments**

alpha	The strictly positive shape parameter of the gamma distribution ( $\alpha > 0$ ).
beta	The strictly positive scale parameter of the gamma distribution ( $\beta > 0$ ).
delta	The strictly positive parameter ( $\delta > 0$ ) and ( $\delta \neq 1$ ).

**Details**

The following is the probability density function of the gamma distribution:

$$f(x) = \frac{\beta^\alpha}{\Gamma(\alpha)} x^{\alpha-1} e^{-\beta x},$$

where  $x > 0$ ,  $\alpha > 0$  and  $\beta > 0$ , and  $\Gamma(a)$  is the standard gamma function.

**Value**

The functions `Se_gamma`, `re_gamma`, `hce_gamma`, and `ae_gamma` provide the Shannon entropy, Rényi entropy, Havrda and Charvat entropy, and Arimoto entropy, respectively, depending on the selected parametric values of the gamma distribution and  $\delta$ .

**Author(s)**

Muhammad Imran, Christophe Chesneau and Farrukh Jamal

R implementation and documentation: Muhammad Imran <imranshako084@yahoo.com>, Christophe Chesneau <christophe.chesneau@unicaen.fr> and Farrukh Jamal <farrukh.jamal@iub.edu.pk>.

**References**

Burgin, T. A. (1975). The gamma distribution and inventory control. *Journal of the Operational Research Society*, 26(3), 507-525.

**See Also**

[re\\_exp](#), [re\\_wei](#)

**Examples**

```
Se_gamma(1.2, 1.4)
delta <- c(1.5, 2, 3)
re_gamma(1.2, 1.4, delta)
hce_gamma(1.2, 1.4, delta)
ae_gamma(1.2, 1.4, delta)
```

---

Gompertz distribution *Compute the Shannon, Rényi, Havrda and Charvat, and Arimoto entropies of the Gompertz distribution*

---

### Description

Compute the Shannon, Rényi, Havrda and Charvat, and Arimoto entropies of the Gompertz distribution.

### Usage

```
se_gomp(alpha, beta)
re_gomp(alpha, beta, delta)
hce_gomp(alpha, beta, delta)
ae_gomp(alpha, beta, delta)
```

### Arguments

alpha	The strictly positive parameter of the Gompertz distribution ( $\alpha > 0$ ).
beta	The strictly positive parameter of the Gompertz distribution ( $\beta > 0$ ).
delta	The strictly positive parameter ( $\delta > 0$ ) and ( $\delta \neq 1$ ).

### Details

The following is the probability density function of the Gompertz distribution:

$$f(x) = \alpha e^{\beta x - \frac{\alpha}{\beta}(e^{\beta x} - 1)},$$

where  $x > 0$ ,  $\alpha > 0$  and  $\beta > 0$ .

### Value

The functions `se_gomp`, `re_gomp`, `hce_gomp`, and `ae_gomp` provide the Shannon entropy, Rényi entropy, Havrda and Charvat entropy, and Arimoto entropy, respectively, depending on the selected parametric values of the Gompertz distribution and  $\delta$ .

### Author(s)

Muhammad Imran, Christophe Chesneau and Farrukh Jamal

R implementation and documentation: Muhammad Imran <imranshakoor84@yahoo.com>, Christophe Chesneau <christophe.chesneau@unicaen.fr> and Farrukh Jamal <farrukh.jamal@iub.edu.pk>.

### References

Soliman, A. A., Abd-Allah, A. H., Abou-Elheggag, N. A., & Abd-Elmougod, G. A. (2012). Estimation of the parameters of life for Gompertz distribution using progressive first-failure censored data. *Computational Statistics & Data Analysis*, 56(8), 2471-2485.

**See Also**

[re\\_exp](#), [re\\_gamma](#), [re\\_ray](#)

**Examples**

```
se_gomp(2.4,0.2)
delta <- c(2, 3)
re_gomp(2.4,0.2, delta)
hce_gomp(2.4,0.2, delta)
ae_gomp(2.4,0.2, delta)
```

---

Gumbel distribution    *Compute the Shannon, Rényi, Havrda and Charvat, and Arimoto entropies of the Gumbel distribution*

---

**Description**

Compute the Shannon, Rényi, Havrda and Charvat, and Arimoto entropies of the Gumbel distribution.

**Usage**

```
Se_gum(alpha, beta)
re_gum(alpha, beta, delta)
hce_gum(alpha, beta, delta)
ae_gum(alpha, beta, delta)
```

**Arguments**

alpha	The location parameter of the Gumbel distribution ( $\alpha \in (-\infty, +\infty)$ ).
beta	The strictly positive scale parameter of the Gumbel distribution ( $\beta > 0$ ).
delta	The strictly positive parameter ( $\delta > 0$ ) and ( $\delta \neq 1$ ).

**Details**

The following is the probability density function of the Gumbel distribution:

$$f(x) = \frac{1}{\beta} e^{-(z+e^{-z})},$$

where  $z = \frac{x-\alpha}{\beta}$ ,  $x \in (-\infty, +\infty)$ ,  $\alpha \in (-\infty, +\infty)$  and  $\beta > 0$ .

**Value**

The functions `Se_gum`, `re_gum`, `hce_gum`, and `ae_gum` provide the Shannon entropy, Rényi entropy, Havrda and Charvat entropy, and Arimoto entropy, respectively, depending on the selected parametric values of the Gumbel distribution and  $\delta$ .

**Author(s)**

Muhammad Imran, Christophe Chesneau and Farrukh Jamal

R implementation and documentation: Muhammad Imran <imranshakoor84@yahoo.com>, Christophe Chesneau <christophe.chesneau@unicaen.fr> and Farrukh Jamal <farrukh.jamal@iub.edu.pk>.

**References**

Gomez, Y. M., Bolfarine, H., & Gomez, H. W. (2019). Gumbel distribution with heavy tails and applications to environmental data. *Mathematics and Computers in Simulation*, 157, 115-129.

**See Also**

[re\\_norm](#)

**Examples**

```
Se_gum(1.2, 1.4)
delta <- c(2, 3)
re_gum(1.2, 0.4, delta)
hce_gum(1.2, 0.4, delta)
ae_gum(1.2, 0.4, delta)
```

---

Inverse-gamma distribution

*Compute the Shannon, Rényi, Havrda and Charvat, and Arimoto entropies of the inverse-gamma distribution*

---

**Description**

Compute the Shannon, Rényi, Havrda and Charvat, and Arimoto entropies of the inverse-gamma distribution.

**Usage**

```
se_ig(alpha, beta)
re_ig(alpha, beta, delta)
hce_ig(alpha, beta, delta)
ae_ig(alpha, beta, delta)
```

**Arguments**

alpha	The strictly positive shape parameter of the inverse-gamma distribution ( $\alpha > 0$ ).
beta	The strictly positive scale parameter of the inverse-gamma distribution ( $\beta > 0$ ).
delta	The strictly positive parameter ( $\delta > 0$ ) and ( $\delta \neq 1$ ).

**Details**

The following is the probability density function of the inverse-gamma distribution:

$$f(x) = \frac{\beta^\alpha}{\Gamma(\alpha)} x^{-\alpha-1} e^{-\frac{\beta}{x}},$$

where  $x > 0$ ,  $\alpha > 0$  and  $\beta > 0$ , and  $\Gamma(a)$  is the standard gamma function.

**Value**

The functions `se_ig`, `re_ig`, `hce_ig`, and `ae_ig` provide the Shannon entropy, Rényi entropy, Havrda and Charvat entropy, and Arimoto entropy, respectively, depending on the selected parametric values of the inverse-gamma distribution and  $\delta$ .

**Author(s)**

Muhammad Imran, Christophe Chesneau and Farrukh Jamal

R implementation and documentation: Muhammad Imran <imranshako0r84@yahoo.com>, Christophe Chesneau <christophe.chesneau@unicaen.fr> and Farrukh Jamal <farrukh.jamal@iub.edu.pk>.

**References**

Rivera, P. A., Calderín-Ojeda, E., Gallardo, D. I., & Gómez, H. W. (2021). A compound class of the inverse Gamma and power series distributions. *Symmetry*, 13(8), 1328.

Glen, A. G. (2017). On the inverse gamma as a survival distribution. *Computational Probability Applications*, 15-30.

**See Also**

[re\\_exp](#), [re\\_gamma](#)

**Examples**

```
se_ig(1.2, 0.2)
delta <- c(1.5, 2, 3)
re_ig(1.2, 0.2, delta)
hce_ig(1.2, 0.2, delta)
ae_ig(1.2, 0.2, delta)
```

---

Kumaraswamy distribution

*Compute the Shannon, Rényi, Havrda and Charvat, and Arimoto entropies of the Kumaraswamy distribution*

---

**Description**

Compute the Shannon, Rényi, Havrda and Charvat, and Arimoto entropies of the Kumaraswamy distribution.

**Usage**

```
se_kum(alpha, beta)
re_kum(alpha, beta, delta)
hce_kum(alpha, beta, delta)
ae_kum(alpha, beta, delta)
```

**Arguments**

alpha	The strictly positive shape parameter of the Kumaraswamy distribution ( $\alpha > 0$ ).
beta	The strictly positive shape parameter of the Kumaraswamy distribution ( $\beta > 0$ ).
delta	The strictly positive scale parameter ( $\delta > 0$ ).

**Details**

The following is the probability density function of the Kumaraswamy distribution:

$$f(x) = \alpha\beta x^{\alpha-1} (1 - x^\alpha)^{\beta-1},$$

where  $0 \leq x \leq 1$ ,  $\alpha > 0$  and  $\beta > 0$ .

**Value**

The functions `se_kum`, `re_kum`, `hce_kum`, and `ae_kum` provide the Shannon entropy, Rényi entropy, Havrda and Charvat entropy, and Arimoto entropy, respectively, depending on the selected parametric values of the Kumaraswamy distribution and  $\delta$ .

**Author(s)**

Muhammad Imran, Christophe Chesneau and Farrukh Jamal

R implementation and documentation: Muhammad Imran <imranshakoor84@yahoo.com>, Christophe Chesneau <christophe.chesneau@unicaen.fr> and Farrukh Jamal <farrukh.jamal@iub.edu.pk>.

**References**

El-Sherpieny, E. S. A., & Ahmed, M. A. (2014). On the Kumaraswamy distribution. *International Journal of Basic and Applied Sciences*, 3(4), 372.

Al-Babtain, A. A., Elbatal, I., Chesneau, C., & Elgarhy, M. (2021). Estimation of different types of entropies for the Kumaraswamy distribution. *PLoS One*, 16(3), e0249027.

**See Also**

[re\\_beta](#)

**Examples**

```
se_kum(1.2, 1.4)
delta <- c(1.5, 2, 3)
re_kum(1.2, 1.4, delta)
hce_kum(1.2, 1.4, delta)
ae_kum(1.2, 1.4, delta)
```

---

Kumaraswamy exponential distribution

*Compute the Rényi, Havrda and Charvat, and Arimoto entropies of the Kumaraswamy exponential distribution*

---

### Description

Compute the Rényi, Havrda and Charvat, and Arimoto entropies of the Kumaraswamy exponential distribution.

### Usage

```
re_kexp(lambda, a, b, delta)
hce_kexp(lambda, a, b, delta)
ae_kexp(lambda, a, b, delta)
```

### Arguments

a	The strictly positive shape parameter of the Kumaraswamy distribution ( $a > 0$ ).
b	The strictly positive shape parameter of the Kumaraswamy distribution ( $b > 0$ ).
lambda	The strictly positive parameter of the exponential distribution ( $\lambda > 0$ ).
delta	The strictly positive parameter ( $\delta > 0$ ) and ( $\delta \neq 1$ ).

### Details

The following is the probability density function of the Kumaraswamy exponential distribution:

$$f(x) = ab\lambda e^{-\lambda x} (1 - e^{-\lambda x})^{a-1} \left\{ 1 - (1 - e^{-\lambda x})^a \right\}^{b-1},$$

where  $x > 0$ ,  $a > 0$ ,  $b > 0$  and  $\lambda > 0$ .

### Value

The functions `re_kexp`, `hce_kexp`, and `ae_kexp` provide the Rényi entropy, Havrda and Charvat entropy, and Arimoto entropy, respectively, depending on the selected parametric values of the Kumaraswamy exponential distribution and  $\delta$ .

### Author(s)

Muhammad Imran, Christophe Chesneau and Farrukh Jamal

R implementation and documentation: Muhammad Imran <imranshako084@yahoo.com>, Christophe Chesneau <christophe.chesneau@unicaen.fr> and Farrukh Jamal <farrukh.jamal@iub.edu.pk>.

### References

Cordeiro, G. M., & de Castro, M. (2011). A new family of generalized distributions. *Journal of Statistical Computation and Simulation*, 81(7), 883-898.

**See Also**

[re\\_exp](#), [re\\_kum](#)

**Examples**

```
delta <- c(1.5, 2, 3)
re_kexp(1.2, 1.2, 1.4, delta)
hce_kexp(1.2, 1.2, 1.4, delta)
ae_kexp(1.2, 1.2, 1.4, delta)
```

---

Kumaraswamy normal distribution

*Compute the Shannon, Rényi, Havrda and Charvat, and Arimoto entropies of the Kumaraswamy normal distribution*

---

**Description**

Compute the Shannon, Rényi, Havrda and Charvat, and Arimoto entropies of the Kumaraswamy normal distribution.

**Usage**

```
se_kumnorm(mu, sigma, a, b)
re_kumnorm(mu, sigma, a, b, delta)
hce_kumnorm(mu, sigma, a, b, delta)
ae_kumnorm(mu, sigma, a, b, delta)
```

**Arguments**

mu	The location parameter of the normal distribution ( $\mu \in (-\infty, +\infty)$ ).
sigma	The strictly positive scale parameter of the normal distribution ( $\sigma > 0$ ).
a	The strictly positive shape parameter of the Kumaraswamy distribution ( $a > 0$ ).
b	The strictly positive shape parameter of the Kumaraswamy distribution ( $b > 0$ ).
delta	The strictly positive parameter ( $\delta > 0$ ) and ( $\delta \neq 1$ ).

**Details**

The following is the probability density function of the Kumaraswamy normal distribution:

$$f(x) = \frac{ab}{\sigma} \phi\left(\frac{x-\mu}{\sigma}\right) \left[\Phi\left(\frac{x-\mu}{\sigma}\right)\right]^{a-1} \left[1 - \Phi\left(\frac{x-\mu}{\sigma}\right)\right]^{b-1},$$

where  $x \in (-\infty, +\infty)$ ,  $\mu \in (-\infty, +\infty)$ ,  $\sigma > 0$ ,  $a > 0$  and  $b > 0$ , and the functions  $\phi(t)$  and  $\Phi(t)$ , denote the probability density function and cumulative distribution function of the standard normal distribution, respectively.

**Value**

The functions `se_kumnorm`, `re_kumnorm`, `hce_kumnorm`, and `ae_kumnorm` provide the Shannon entropy, Rényi entropy, Havrda and Charvat entropy, and Arimoto entropy, respectively, depending on the selected parametric values of the Kumaraswamy normal distribution and  $\delta$ .

**Author(s)**

Muhammad Imran, Christophe Chesneau and Farrukh Jamal

R implementation and documentation: Muhammad Imran <imranshako0r84@yahoo.com>, Christophe Chesneau <christophe.chesneau@unicaen.fr> and Farrukh Jamal <farrukh.jamal@iub.edu.pk>.

**References**

Cordeiro, G. M., & de Castro, M. (2011). A new family of generalized distributions. *Journal of Statistical Computation and Simulation*, 81(7), 883-898.

**See Also**

[re\\_norm](#), [re\\_kum](#)

**Examples**

```
se_kumnorm(0.2, 1.5, 1, 1)
delta <- c(1.5, 2, 3)
re_kumnorm(1.2, 1, 2, 1.5, delta)
hce_kumnorm(1.2, 1, 2, 1.5, delta)
ae_kumnorm(1.2, 1, 2, 1.5, delta)
```

---

Laplace distribution    *Compute the Shannon, Rényi, Havrda and Charvat, and Arimoto entropies of the Laplace or the double exponential distribution*

---

**Description**

Compute the Shannon, Rényi, Havrda and Charvat, and Arimoto entropies of the Laplace distribution.

**Usage**

```
se_lap(alpha, beta)
re_lap(alpha, beta, delta)
hce_lap(alpha, beta, delta)
ae_lap(alpha, beta, delta)
```

**Arguments**

alpha	The location parameter of the Laplace distribution ( $\alpha \in (-\infty, +\infty)$ ).
beta	The strictly positive scale parameter of the Laplace distribution ( $\beta > 0$ ).
delta	The strictly positive parameter ( $\delta > 0$ ) and ( $\delta \neq 1$ ).

**Details**

The following is the probability density function of the Laplace distribution:

$$f(x) = \frac{1}{2\beta} e^{-\frac{|x-\alpha|}{\beta}},$$

where  $x \in (-\infty, +\infty)$ ,  $\alpha \in (-\infty, +\infty)$  and  $\beta > 0$ .

**Value**

The functions `Se_lap`, `re_lap`, `hce_lap`, and `ae_lap` provide the Shannon entropy, Rényi entropy, Havrda and Charvat entropy, and Arimoto entropy, respectively, depending on the selected parametric values of the Laplace distribution and  $\delta$ .

**Author(s)**

Muhammad Imran, Christophe Chesneau and Farrukh Jamal

R implementation and documentation: Muhammad Imran <imranshakoor84@yahoo.com>, Christophe Chesneau <christophe.chesneau@unicaen.fr> and Farrukh Jamal <farrukh.jamal@iub.edu.pk>.

**References**

Cordeiro, G. M., & Lemonte, A. J. (2011). The beta Laplace distribution. *Statistics & Probability Letters*, 81(8), 973-982.

**See Also**

[re\\_gum](#), [re\\_norm](#)

**Examples**

```
Se_lap(0.2, 1.4)
delta <- c(2, 3)
re_lap(1.2, 0.4, delta)
hce_lap(1.2, 0.4, delta)
ae_lap(1.2, 0.4, delta)
```

---

Log-normal distribution

*Compute the Shannon, Rényi, Havrda and Charvat, and Arimoto entropies of the log-normal distribution*

---

### Description

Compute the Shannon, Rényi, Havrda and Charvat, and Arimoto entropies of the log-normal distribution.

### Usage

```
se_lnorm(mu, sigma)
re_lnorm(mu, sigma, delta)
hce_lnorm(mu, sigma, delta)
ae_lnorm(mu, sigma, delta)
```

### Arguments

mu	The location parameter ( $\mu \in (-\infty, +\infty)$ ).
sigma	The strictly positive scale parameter of the log-normal distribution ( $\sigma > 0$ ).
delta	The strictly positive parameter ( $\delta > 0$ ) and ( $\delta \neq 1$ ).

### Details

The following is the probability density function of the log-normal distribution:

$$f(x) = \frac{1}{x\sigma\sqrt{2\pi}} e^{-\frac{(\log(x)-\mu)^2}{2\sigma^2}},$$

where  $x > 0$ ,  $\mu \in (-\infty, +\infty)$  and  $\sigma > 0$ .

### Value

The functions `se_lnorm`, `re_lnorm`, `hce_lnorm`, and `ae_lnorm` provide the Shannon entropy, Rényi entropy, Havrda and Charvat entropy, and Arimoto entropy, respectively, depending on the selected parametric values of the log-normal distribution and  $\delta$ .

### Author(s)

Muhammad Imran, Christophe Chesneau and Farrukh Jamal

R implementation and documentation: Muhammad Imran <imranshakoor84@yahoo.com>, Christophe Chesneau <christophe.chesneau@unicaen.fr> and Farrukh Jamal <farrukh.jamal@iub.edu.pk>.

### References

Johnson, N. L., Kotz, S., & Balakrishnan, N. (1995). Continuous univariate distributions, Volume 1, Chapter 14. Wiley, New York.

**See Also**[re\\_wei](#), [re\\_norm](#)**Examples**

```
se_lnorm(0.2, 1.4)
delta <- c(2, 3)
re_lnorm(1.2, 0.4, delta)
hce_lnorm(1.2, 0.4, delta)
ae_lnorm(1.2, 0.4, delta)
```

---

Logistic distribution *Compute the Shannon, Rényi, Havrda and Charvat, and Arimoto entropies of the logistic distribution*

---

**Description**

Compute the Shannon, Rényi, Havrda and Charvat, and Arimoto entropies of the logistic distribution.

**Usage**

```
se_logis(mu, sigma)
re_logis(mu, sigma, delta)
hce_logis(mu, sigma, delta)
ae_logis(mu, sigma, delta)
```

**Arguments**

mu	The location parameter of the logistic distribution ( $\mu \in (-\infty, +\infty)$ ).
sigma	The strictly positive scale parameter of the logistic distribution ( $\sigma > 0$ ).
delta	The strictly positive parameter ( $\delta > 0$ ) and ( $\delta \neq 1$ ).

**Details**

The following is the probability density function of the logistic distribution:

$$f(x) = \frac{e^{-\frac{(x-\mu)}{\sigma}}}{\sigma \left(1 + e^{-\frac{(x-\mu)}{\sigma}}\right)^2},$$

where  $x \in (-\infty, +\infty)$ ,  $\mu \in (-\infty, +\infty)$  and  $\sigma > 0$ .

**Value**

The functions `se_logis`, `re_logis`, `hce_logis`, and `ae_logis` provide the Shannon entropy, Rényi entropy, Havrda and Charvat entropy, and Arimoto entropy, respectively, depending on the selected parametric values of the logistic distribution and  $\delta$ .

**Author(s)**

Muhammad Imran, Christophe Chesneau and Farrukh Jamal

R implementation and documentation: Muhammad Imran <imranshako0r84@yahoo.com>, Christophe Chesneau <christophe.chesneau@unicaen.fr> and Farrukh Jamal <farrukh.jamal@iub.edu.pk>.

**References**

Johnson, N. L., Kotz, S., & Balakrishnan, N. (1995). Continuous univariate distributions, Volume 2 (Vol. 289). John Wiley & Sons.

**See Also**

[re\\_gum](#), [re\\_norm](#)

**Examples**

```
se_logis(0.2, 1.4)
delta <- c(2, 3)
re_logis(1.2, 0.4, delta)
hce_logis(1.2, 0.4, delta)
ae_logis(1.2, 0.4, delta)
```

---

Lomax distribution	<i>Compute the Shannon, Rényi, Havrda and Charvat, and Arimoto entropies of the Lomax distribution</i>
--------------------	--

---

**Description**

Compute the Shannon, Rényi, Havrda and Charvat, and Arimoto entropies of the Lomax distribution.

**Usage**

```
se_lom(alpha, beta)
re_lom(alpha, beta, delta)
hce_lom(alpha, beta, delta)
ae_lom(alpha, beta, delta)
```

**Arguments**

alpha	The strictly positive shape parameter of the Lomax distribution ( $\alpha > 0$ ).
beta	The strictly positive scale parameter of the Lomax distribution ( $\beta > 0$ ).
delta	The strictly positive parameter ( $\delta > 0$ ) and ( $\delta \neq 1$ ).

**Details**

The following is the probability density function of the Lomax distribution:

$$f(x) = \frac{\alpha}{\beta} \left(1 + \frac{x}{\beta}\right)^{-\alpha-1},$$

where  $x > 0$ ,  $\alpha > 0$  and  $\beta > 0$ .

**Value**

The functions `se_lom`, `re_lom`, `hce_lom`, and `ae_lom` provide the Shannon entropy, Rényi entropy, Havrda and Charvat entropy, and Arimoto entropy, respectively, depending on the selected parametric values of the Lomax distribution and  $\delta$ .

**Author(s)**

Muhammad Imran, Christophe Chesneau and Farrukh Jamal

R implementation and documentation: Muhammad Imran <imranshako84@yahoo.com>, Christophe Chesneau <christophe.chesneau@unicaen.fr> and Farrukh Jamal <farrukh.jamal@iub.edu.pk>.

**References**

Abd-Elfattah, A. M., Alaboud, F. M., & Alharby, A. H. (2007). On sample size estimation for Lomax distribution. *Australian Journal of Basic and Applied Sciences*, 1(4), 373-378.

**See Also**

[re\\_exp](#), [re\\_gamma](#)

**Examples**

```
se_lom(1.2, 0.2)
delta <- c(1.5, 2, 3)
re_lom(1.2, 0.2, delta)
hce_lom(1.2, 0.2, delta)
ae_lom(1.2, 0.2, delta)
```

---

Nakagami distribution *Compute the Shannon, Rényi, Havrda and Charvat, and Arimoto entropies of the Nakagami distribution*

---

**Description**

Compute the Shannon, Rényi, Havrda and Charvat, and Arimoto entropies of the Nakagami distribution.

**Usage**

```
se_naka(alpha, beta)
re_naka(alpha, beta, delta)
hce_naka(alpha, beta, delta)
ae_naka(alpha, beta, delta)
```

**Arguments**

alpha	The strictly positive scale parameter of the Nakagami distribution ( $\alpha > 0$ ).
beta	The strictly positive shape parameter of the Nakagami distribution ( $\beta > 0$ ).
delta	The strictly positive parameter ( $\delta > 0$ ) and ( $\delta \neq 1$ ).

**Details**

The following is the probability density function of the Nakagami distribution:

$$f(x) = \frac{2\alpha^\alpha}{\Gamma(\alpha)\beta^\alpha} x^{2\alpha-1} e^{-\frac{\alpha x^2}{\beta}},$$

where  $x > 0$ ,  $\alpha > 0$  and  $\beta > 0$ , and  $\Gamma(a)$  is the standard gamma function.

**Value**

The functions `se_naka`, `re_naka`, `hce_naka`, and `ae_naka` provide the Shannon entropy, Rényi entropy, Havrda and Charvat entropy, and Arimoto entropy, respectively, depending on the selected parametric values of the Nakagami distribution and  $\delta$ .

**Author(s)**

Muhammad Imran, Christophe Chesneau and Farrukh Jamal

R implementation and documentation: Muhammad Imran <imranshakoor84@yahoo.com>, Christophe Chesneau <christophe.chesneau@unicaen.fr> and Farrukh Jamal <farrukh.jamal@iub.edu.pk>.

**References**

Schwartz, J., Godwin, R. T., & Giles, D. E. (2013). Improved maximum-likelihood estimation of the shape parameter in the Nakagami distribution. *Journal of Statistical Computation and Simulation*, 83(3), 434-445.

**See Also**

[re\\_exp](#), [re\\_gamma](#), [re\\_wei](#)

**Examples**

```
se_naka(1.2, 0.2)
delta <- c(1.5, 2, 3)
re_naka(1.2, 0.2, delta)
hce_naka(1.2, 0.2, delta)
ae_naka(1.2, 0.2, delta)
```

---

Normal distribution     *Compute the Shannon, Rényi, Havrda and Charvat, and Arimoto entropies of the normal distribution*

---

### Description

Compute the Shannon, Rényi, Havrda and Charvat, and Arimoto entropies of the normal distribution.

### Usage

```
se_norm(alpha, beta)
re_norm(alpha, beta, delta)
hce_norm(alpha, beta, delta)
ae_norm(alpha, beta, delta)
```

### Arguments

alpha	The location parameter of the normal distribution ( $\alpha \in (-\infty, +\infty)$ ).
beta	The strictly positive scale parameter of the normal distribution ( $\beta > 0$ ).
delta	The strictly positive parameter ( $\delta > 0$ ) and ( $\delta \neq 1$ ).

### Details

The following is the probability density function of the normal distribution:

$$f(x) = \frac{1}{\beta\sqrt{2\pi}} e^{-0.5\left(\frac{x-\alpha}{\beta}\right)^2},$$

where  $x \in (-\infty, +\infty)$ ,  $\alpha \in (-\infty, +\infty)$  and  $\beta > 0$ . The parameters  $\alpha$  and  $\beta$  represent the mean and standard deviation, respectively.

### Value

The functions `se_norm`, `re_norm`, `hce_norm`, and `ae_norm` provide the Shannon entropy, Rényi entropy, Havrda and Charvat entropy, and Arimoto entropy, respectively, depending on the selected parametric values of the Normal distribution and  $\delta$ .

### Author(s)

Muhammad Imran, Christophe Chesneau and Farrukh Jamal

R implementation and documentation: Muhammad Imran <imranshakoor84@yahoo.com>, Christophe Chesneau <christophe.chesneau@unicaen.fr> and Farrukh Jamal <farrukh.jamal@iub.edu.pk>.

### References

Patel, J. K., & Read, C. B. (1996). Handbook of the normal distribution (Vol. 150). CRC Press.

**See Also**[re\\_gum](#)**Examples**

```
se_norm(0.2, 1.4)
delta <- c(1.5, 2, 3)
re_norm(0.2, 1.4, delta)
hce_norm(0.2, 1.4, delta)
ae_norm(0.2, 1.4, delta)
```

---

Rayleigh distribution *Compute the Shannon, Rényi, Havrda and Charvat, and Arimoto entropies of the Rayleigh distribution*

---

**Description**

Compute the Shannon, Rényi, Havrda and Charvat, and Arimoto entropies of the Rayleigh distribution.

**Usage**

```
se_ray(alpha)
re_ray(alpha, delta)
hce_ray(alpha, delta)
ae_ray(alpha, delta)
```

**Arguments**

`alpha`            The strictly positive parameter of the Rayleigh distribution ( $\alpha > 0$ ).

`delta`            The strictly positive parameter ( $\delta > 0$ ) and ( $\delta \neq 1$ ).

**Details**

The following is the probability density function of the Rayleigh distribution:

$$f(x) = 2\alpha x e^{-\alpha x^2},$$

where  $x > 0$  and  $\alpha > 0$ .

**Value**

The functions `se_ray`, `re_ray`, `hce_ray`, and `ae_ray` provide the Shannon entropy, Rényi entropy, Havrda and Charvat entropy, and Arimoto entropy, respectively, depending on the selected parametric values of the Rayleigh distribution and  $\delta$ .

**Author(s)**

Muhammad Imran, Christophe Chesneau and Farrukh Jamal

R implementation and documentation: Muhammad Imran <imranshakoor84@yahoo.com>, Christophe Chesneau <christophe.chesneau@unicaen.fr> and Farrukh Jamal <farrukh.jamal@iub.edu.pk>.

**References**

Dey, S., Maiti, S. S., & Ahmad, M. (2016). Comparison of different entropy measures. *Pak. J. Statist*, 32(2), 97-108.

Arimoto, S. (1971). Information-theoretical considerations on estimation problems. *Inf. Control*, 19, 181–194.

**See Also**

[re\\_exp](#), [re\\_gamma](#), [re\\_wei](#)

**Examples**

```
se_ray(0.2)
delta <- c(1.5, 2, 3)
re_ray(0.2, delta)
hce_ray(0.2, delta)
ae_ray(0.2, delta)
# A graphic representation of the Rényi entropy (RE)
library(ggplot2)
delta <- c(1.5, 2, 3)
z <- re_ray(0.2, delta)
dat <- data.frame(x = delta , RE = z)
p_re <- ggplot(dat, aes(x = delta, y = RE)) + geom_line()
plot <- p_re + ggtitle(expression(alpha == 0.2))
# A graphic presentation of the Havrda and Charvat entropy (HCE)
delta <- c(1.5, 2, 3)
z <- hce_ray(0.2, delta)
dat <- data.frame(x = delta , HCE = z)
p_hce <- ggplot(dat, aes(x = delta, y = HCE)) + geom_line()
plot <- p_hce + ggtitle(expression(alpha == 0.2))
```

---

Student's *t* distribution

*Compute the Shannon, Rényi, Havrda and Charvat, and Arimoto entropies of the Student's *t* distribution*

---

**Description**

Compute the Shannon, Rényi, Havrda and Charvat, and Arimoto entropies of the Student's *t* distribution.

**Usage**

```
se_st(v)
re_st(v, delta)
hce_st(v, delta)
ae_st(v, delta)
```

**Arguments**

`v` The strictly positive parameter of the Student's *t* distribution ( $v > 0$ ), also called a degree of freedom.

`delta` The strictly positive parameter ( $\delta > 0$ ) and ( $\delta \neq 1$ ).

**Details**

The following is the probability density function of the Student *t* distribution:

$$f(x) = \frac{\Gamma(\frac{v+1}{2})}{\sqrt{v\pi}\Gamma(\frac{v}{2})} \left(1 + \frac{x^2}{v}\right)^{-(v+1)/2},$$

where  $x \in (-\infty, +\infty)$  and  $v > 0$ , and  $\Gamma(a)$  is the standard gamma function.

**Value**

The functions `se_st`, `re_st`, `hce_st`, and `ae_st` provide the Shannon entropy, Rényi entropy, Havrda and Charvat entropy, and Arimoto entropy, respectively, depending on the selected parametric values of the Student's *t* distribution and  $\delta$ .

**Author(s)**

Muhammad Imran, Christophe Chesneau and Farrukh Jamal

R implementation and documentation: Muhammad Imran <imranshako0r84@yahoo.com>, Christophe Chesneau <christophe.chesneau@unicaen.fr> and Farrukh Jamal <farrukh.jamal@iub.edu.pk>.

**References**

Yang, Z., Fang, K. T., & Kotz, S. (2007). On the Student's *t*-distribution and the *t*-statistic. *Journal of Multivariate Analysis*, 98(6), 1293-1304.

Ahsanullah, M., Kibria, B. G., & Shakil, M. (2014). *Normal and Student's t distributions and their applications* (Vol. 4). Paris, France: Atlantis Press.

Arimoto, S. (1971). Information-theoretical considerations on estimation problems. *Inf. Control*, 19, 181-194.

**See Also**

[re\\_exp](#), [re\\_gamma](#)

**Examples**

```
se_st(4)
delta <- c(1.5, 2, 3)
re_st(4, delta)
hce_st(4, delta)
ae_st(4, delta)
```

---

Truncated beta distribution

*Relative loss for various entropy measures using the truncated beta distribution*

---

**Description**

Compute the relative information loss of the Shannon, Rényi, Havrda and Charvat, and Arimoto entropies of the truncated beta distribution.

**Usage**

```
rlse_beta(p, alpha, beta)
rlre_beta(p, alpha, beta, delta)
rlhce_beta(p, alpha, beta, delta)
rlae_beta(p, alpha, beta, delta)
```

**Arguments**

alpha	The strictly positive shape parameter of the beta distribution ( $\alpha > 0$ ).
beta	The strictly positive shape parameter of the beta distribution ( $\beta > 0$ ).
p	The truncation time ( $p > 0$ ).
delta	The strictly positive parameter ( $\delta > 0$ ) and ( $\delta \neq 1$ ).

**Value**

The functions `rlse_beta`, `rlre_beta`, `rlhce_beta`, and `rlae_beta` provide the relative information loss based on the Shannon entropy, Rényi entropy, Havrda and Charvat entropy, and Arimoto entropy, respectively, depending on the selected parametric values of the truncated beta distribution,  $p$  and  $\delta$ .

**Author(s)**

Muhammad Imran, Christophe Chesneau and Farrukh Jamal

R implementation and documentation: Muhammad Imran <imranshako0r84@yahoo.com>, Christophe Chesneau <christophe.chesneau@unicaen.fr> and Farrukh Jamal <farrukh.jamal@iub.edu.pk>.

**References**

- Gupta, A. K., & Nadarajah, S. (2004). Handbook of beta distribution and its applications. CRC Press.
- Awad, A. M., & Alawneh, A. J. (1987). Application of entropy to a life-time model. IMA Journal of Mathematical Control and Information, 4(2), 143-148.

**See Also**

[re\\_beta](#)

**Examples**

```
p <- c(0.25, 0.50, 0.75)
rlse_beta(p, 0.2, 0.4)
rlre_beta(p, 0.2, 0.4, 0.5)
rlhce_beta(p, 0.2, 0.4, 0.5)
rlae_beta(p, 0.2, 0.4, 0.5)
```

---

Truncated Birnbaum-Saunders distribution

*Relative loss for various entropy measures using the truncated Birnbaum-Saunders distribution*

---

**Description**

Compute the relative information loss of the Shannon, Rényi, Havrda and Charvat, and Arimoto entropies of the truncated Birnbaum-Saunders distribution.

**Usage**

```
rlse_bs(p, v)
rlre_bs(p, v, delta)
rlhce_bs(p, v, delta)
rlae_bs(p, v, delta)
```

**Arguments**

- |       |  |
|-------|--|
| v     | The strictly positive scale parameter of the Birnbaum-Saunders distribution ( $v > 0$ ). |
| p     | The truncation time ( $p > 0$ ).   |
| delta | The strictly positive parameter ( $\delta > 0$ ) and ( $\delta \neq 1$ ).                |

**Value**

The functions `rlse_bs`, `rlre_bs`, `rlhce_bs`, and `rlae_bs` provide the relative information loss based on the Shannon entropy, Rényi entropy, Havrda and Charvat entropy, and Arimoto entropy, respectively, depending on the selected parametric values of the truncated Birnbaum-Saunders distribution,  $p$  and  $\delta$ .

**Author(s)**

Muhammad Imran, Christophe Chesneau and Farrukh Jamal

R implementation and documentation: Muhammad Imran <imranshakoor84@yahoo.com>, Christophe Chesneau <christophe.chesneau@unicaen.fr> and Farrukh Jamal <farrukh.jamal@iub.edu.pk>.

**References**

Awad, A. M., & Alawneh, A. J. (1987). Application of entropy to a life-time model. *IMA Journal of Mathematical Control and Information*, 4(2), 143-148.

Chan, S., Nadarajah, S., & Afuecheta, E. (2016). An R package for value at risk and expected shortfall. *Communications in Statistics Simulation and Computation*, 45(9), 3416-3434.

Arimoto, S. (1971). Information-theoretical considerations on estimation problems. *Inf. Control*, 19, 181-194.

**See Also**

[re\\_bs](#)

**Examples**

```
p <- c(1, 1.7, 3)
rlse_bs(p, 0.2)
rlre_bs(p, 0.2, 0.5)
rlhce_bs(p, 0.2, 0.5)
rlae_bs(p, 0.2, 0.5)
```

---

Truncated Chi-squared distribution

*Relative loss for various entropy measures using the truncated Chi-squared distribution*

---

**Description**

Compute the relative information loss of the Shannon, Rényi, Havrda and Charvat, and Arimoto entropies of the truncated Chi-squared distribution.

**Usage**

```
rlse_chi(p, n)
rlre_chi(p, n, delta)
rlhce_chi(p, n, delta)
rlae_chi(p, n, delta)
```

**Arguments**

n	The degree of freedom and positive parameter of the Chi-squared distribution ( $n > 0$ ).
p	The truncation time ( $p > 0$ ).
delta	The strictly positive parameter ( $\delta > 0$ ) and ( $\delta \neq 1$ ).

**Value**

The functions `rlse_chi`, `rlre_chi`, `rlhce_chi`, and `rlae_chi` provide the relative information loss based on the Shannon entropy, Rényi entropy, Havrda and Charvat entropy, and Arimoto entropy, respectively, depending on the selected parametric values of the truncated Chi-squared distribution,  $p$  and  $\delta$ .

**Author(s)**

Muhammad Imran, Christophe Chesneau and Farrukh Jamal

R implementation and documentation: Muhammad Imran <imranshako0r84@yahoo.com>, Christophe Chesneau <christophe.chesneau@unicaen.fr> and Farrukh Jamal <farrukh.jamal@iub.edu.pk>.

**References**

Awad, A. M., & Alawneh, A. J. (1987). Application of entropy to a life-time model. *IMA Journal of Mathematical Control and Information*, 4(2), 143-148.

Johnson, N. L., Kotz, S., & Balakrishnan, N. (1995). *Continuous univariate distributions*, volume 2 (Vol. 289). John Wiley & Sons.

**See Also**

[re\\_chi](#)

**Examples**

```
p <- c(1, 1.7, 3)
rlse_chi(p, 2)
rlre_chi(p, 2, 0.5)
rlhce_chi(p, 2, 0.5)
rlae_chi(p, 2, 0.5)
```

---

Truncated exponential distribution

*Relative loss for various entropy measures using the truncated exponential distribution*

---

**Description**

Compute the relative information loss of the Shannon, Rényi, Havrda and Charvat, and Arimoto entropies of the truncated exponential distribution.

**Usage**

```
rlse_exp(p, alpha)
rlre_exp(p, alpha, delta)
rlhce_exp(p, alpha, delta)
rlae_exp(p, alpha, delta)
```

**Arguments**

alpha	The strictly positive scale parameter of the exponential distribution ( $\alpha > 0$ ).
p	The truncation time ( $p > 0$ ).
delta	The strictly positive parameter ( $\delta > 0$ ) and ( $\delta \neq 1$ ).

**Value**

The functions `rlse_exp`, `rlre_exp`, `rlhce_exp`, and `rlae_exp` provide the relative information loss based on the Shannon entropy, Rényi entropy, Havrda and Charvat entropy, and Arimoto entropy, respectively, depending on the selected parametric values of the truncated exponential distribution,  $p$  and  $\delta$ .

**Author(s)**

Muhammad Imran, Christophe Chesneau and Farrukh Jamal

R implementation and documentation: Muhammad Imran <imranshakoor84@yahoo.com>, Christophe Chesneau <christophe.chesneau@unicaen.fr> and Farrukh Jamal <farrukh.jamal@iub.edu.pk>.

**References**

Awad, A. M., & Alawneh, A. J. (1987). Application of entropy to a life-time model. *IMA Journal of Mathematical Control and Information*, 4(2), 143-148.

**See Also**

[re\\_exp](#)

**Examples**

```
p <- c(1, 1.7, 3)
rlse_exp(p, 2)
rlre_exp(p, 2, 0.5)
rlhce_exp(p, 2, 0.5)
rlae_exp(p, 2, 0.5)
```

---

Truncated exponential extension distribution

*Relative loss for various entropy measures using the truncated exponential extension distribution*

---

### Description

Compute the relative information loss of the Shannon, Rényi, Havrda and Charvat, and Arimoto entropies of the truncated exponential extension distribution.

### Usage

```
rlse_nh(p, alpha, beta)
rlre_nh(p, alpha, beta, delta)
rlhce_nh(p, alpha, beta, delta)
rlae_nh(p, alpha, beta, delta)
```

### Arguments

alpha	The strictly positive parameter of the exponential extension distribution ( $\alpha > 0$ ).
beta	The strictly positive parameter of the exponential extension distribution ( $\beta > 0$ ).
p	The truncation time ( $p > 0$ ).
delta	The strictly positive parameter ( $\delta > 0$ ) and ( $\delta \neq 1$ ).

### Value

The functions `rlse_nh`, `rlre_nh`, `rlhce_nh`, and `rlae_nh` provide the relative information loss based on the Shannon entropy, Rényi entropy, Havrda and Charvat entropy, and Arimoto entropy, respectively, depending on the selected parametric values of the truncated exponential extension distribution,  $p$  and  $\delta$ .

### Author(s)

Muhammad Imran, Christophe Chesneau and Farrukh Jamal

R implementation and documentation: Muhammad Imran <imranshakoor84@yahoo.com>, Christophe Chesneau <christophe.chesneau@unicaen.fr> and Farrukh Jamal <farrukh.jamal@iub.edu.pk>.

### References

Awad, A. M., & Alawneh, A. J. (1987). Application of entropy to a life-time model. *IMA Journal of Mathematical Control and Information*, 4(2), 143-148.

Nadarajah, S., & Haghighi, F. (2011). An extension of the exponential distribution. *Statistics*, 45(6), 543-558.

### See Also

[re\\_nh](#)

**Examples**

```
p <- c(0.25, 0.50, 0.75)
rlse_nh(p, 1.2, 0.2)
rlre_nh(p, 1.2, 0.2, 0.5)
rlhce_nh(p, 1.2, 0.2, 0.5)
rlae_nh(p, 1.2, 0.2, 0.5)
```

---

Truncated F distribution

*Relative loss for various entropy measures using the truncated F distribution*

---

**Description**

Compute the relative information loss of the Shannon, Rényi, Havrda and Charvat, and Arimoto entropies of the truncated F distribution.

**Usage**

```
rlse_f(p, alpha, beta)
rlre_f(p, alpha, beta, delta)
rlhce_f(p, alpha, beta, delta)
rlae_f(p, alpha, beta, delta)
```

**Arguments**

alpha	The strictly positive parameter (first degree of freedom) of the F distribution ( $\alpha > 0$ ).
beta	The strictly positive parameter (second degree of freedom) of the F distribution ( $\beta > 0$ ).
p	The truncation time ( $p > 0$ ).
delta	The strictly positive parameter ( $\delta > 0$ ) and ( $\delta \neq 1$ ).

**Value**

The functions `rlse_f`, `rlre_f`, `rlhce_f`, and `rlae_f` provide the relative information loss based on the Shannon entropy, Rényi entropy, Havrda and Charvat entropy, and Arimoto entropy, respectively, depending on the selected parametric values of the truncated F distribution,  $p$  and  $\delta$ .

**Author(s)**

Muhammad Imran, Christophe Chesneau and Farrukh Jamal

R implementation and documentation: Muhammad Imran <imranshako0r84@yahoo.com>, Christophe Chesneau <christophe.chesneau@unicaen.fr> and Farrukh Jamal <farrukh.jamal@iub.edu.pk>.

**References**

Awad, A. M., & Alawneh, A. J. (1987). Application of entropy to a life-time model. *IMA Journal of Mathematical Control and Information*, 4(2), 143-148. Johnson, N. L., Kotz, S., & Balakrishnan, N. (1995). *Continuous univariate distributions*, volume 2 (Vol. 289). John Wiley & Sons.

**See Also**

[re\\_f](#)

**Examples**

```
p <- c(1.25, 1.50, 1.75)
rlse_f(p, 4, 6)
rlre_f(p, 4, 6, 0.5)
rlhce_f(p, 4, 6, 0.5)
rlae_f(p, 4, 6, 0.5)
```

---

Truncated gamma distribution

*Relative loss for various entropy measures using the truncated gamma distribution*

---

**Description**

Compute the relative information loss of the Shannon, Rényi, Havrda and Charvat, and Arimoto entropies of the truncated gamma distribution.

**Usage**

```
rlse_gamma(p, alpha, beta)
rlre_gamma(p, alpha, beta, delta)
rlhce_gamma(p, alpha, beta, delta)
rlae_gamma(p, alpha, beta, delta)
```

**Arguments**

alpha	The strictly positive shape parameter of the gamma distribution ( $\alpha > 0$ ).
beta	The strictly positive scale parameter of the gamma distribution ( $\beta > 0$ ).
p	The truncation time ( $p > 0$ ).
delta	The strictly positive parameter ( $\delta > 0$ ) and ( $\delta \neq 1$ ).

**Value**

The functions `rlse_gamma`, `rlre_gamma`, `rlhce_gamma`, and `rlae_gamma` provide the relative information loss based on the Shannon entropy, Rényi entropy, Havrda and Charvat entropy, and Arimoto entropy, respectively, depending on the selected parametric values of the truncated gamma distribution,  $p$  and  $\delta$ .

**Author(s)**

Muhammad Imran, Christophe Chesneau and Farrukh Jamal

R implementation and documentation: Muhammad Imran <imranshakoor84@yahoo.com>, Christophe Chesneau <christophe.chesneau@unicaen.fr> and Farrukh Jamal <farrukh.jamal@iub.edu.pk>.

**References**

Awad, A. M., & Alawneh, A. J. (1987). Application of entropy to a life-time model. *IMA Journal of Mathematical Control and Information*, 4(2), 143-148.

Burgin, T. A. (1975). The gamma distribution and inventory control. *Journal of the Operational Research Society*, 26(3), 507-525.

**See Also**

[re\\_gamma](#)

**Examples**

```
p <- c(1, 1.50, 1.75)
rlse_gamma(p, 0.2, 1)
rlre_gamma(p, 0.2, 1, 0.5)
rlhce_gamma(p, 0.2, 1, 0.5)
rlae_gamma(p, 0.2, 1, 0.5)
```

---

Truncated Gompertz distribution

*Relative loss for various entropy measures using the truncated Gompertz distribution*

---

**Description**

Compute the relative information loss of the Shannon, Rényi, Havrda and Charvat, and Arimoto entropies of the truncated Gompertz distribution.

**Usage**

```
rlse_gomp(p, alpha, beta)
rlre_gomp(p, alpha, beta, delta)
rlhce_gomp(p, alpha, beta, delta)
rlae_gomp(p, alpha, beta, delta)
```

**Arguments**

alpha	The strictly positive parameter of the Gompertz distribution ( $\alpha > 0$ ).
beta	The strictly positive parameter of the Gompertz distribution ( $\beta > 0$ ).
p	The truncation time ( $p > 0$ ).
delta	The strictly positive parameter ( $\delta > 0$ ) and ( $\delta \neq 1$ ).

**Value**

The functions `rlse_gomp`, `rlre_gomp`, `rlhce_gomp`, and `rlae_gomp` provide the relative information loss based on the Shannon entropy, Rényi entropy, Havrda and Charvat entropy, and Arimoto entropy, respectively, depending on the selected parametric values of the truncated Gompertz distribution,  $p$  and  $\delta$ .

**Author(s)**

Muhammad Imran, Christophe Chesneau and Farrukh Jamal

R implementation and documentation: Muhammad Imran <imranshakoor84@yahoo.com>, Christophe Chesneau <christophe.chesneau@unicaen.fr> and Farrukh Jamal <farrukh.jamal@iub.edu.pk>.

**References**

Awad, A. M., & Alawneh, A. J. (1987). Application of entropy to a life-time model. *IMA Journal of Mathematical Control and Information*, 4(2), 143-148.

Soliman, A. A., Abd-Ellah, A. H., Abou-Elheggag, N. A., & Abd-Elmougod, G. A. (2012). Estimation of the parameters of life for Gompertz distribution using progressive first-failure censored data. *Computational Statistics & Data Analysis*, 56(8), 2471-2485.

**See Also**

[re\\_gomp](#)

**Examples**

```
p <- c(0.25, 0.50)
rlse_gomp(p, 2.4, 0.2)
rlre_gomp(p, 2.4, 0.2, 0.5)
rlhce_gomp(p, 2.4, 0.2, 0.5)
rlae_gomp(p, 2.4, 0.2, 0.5)
```

---

Truncated Gumbel distribution

*Relative loss for various entropy measures using the truncated Gumbel distribution*

---

**Description**

Compute the relative information loss of the Shannon, Rényi, Havrda and Charvat, and Arimoto entropies of the truncated Gumbel distribution.

**Usage**

```
rlse_gum(p, alpha, beta)
rlre_gum(p, alpha, beta, delta)
rlhce_gum(p, alpha, beta, delta)
rlae_gum(p, alpha, beta, delta)
```

**Arguments**

alpha	The location parameter of the Gumbel distribution ( $\alpha \in (-\infty, +\infty)$ ).
beta	The strictly positive scale parameter of the Gumbel distribution ( $\beta > 0$ ).
p	The truncation time ( $p > 0$ ).
delta	The strictly positive parameter ( $\delta > 0$ ) and ( $\delta \neq 1$ ).

**Value**

The functions `rlse_gum`, `rlre_gum`, `rlhce_gum`, and `rlae_gum` provide the relative information loss based on the Shannon entropy, Rényi entropy, Havrda and Charvat entropy, and Arimoto entropy, respectively, depending on the selected parametric values of the truncated Gumbel distribution,  $p$  and  $\delta$ .

**Author(s)**

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R implementation and documentation: Muhammad Imran <imranshako0r84@yahoo.com>, Christophe Chesneau <christophe.chesneau@unicaen.fr> and Farrukh Jamal <farrukh.jamal@iub.edu.pk>.

**References**

Awad, A. M., & Alawneh, A. J. (1987). Application of entropy to a life-time model. *IMA Journal of Mathematical Control and Information*, 4(2), 143-148.

Gomez, Y. M., Bolfarine, H., & Gomez, H. W. (2019). Gumbel distribution with heavy tails and applications to environmental data. *Mathematics and Computers in Simulation*, 157, 115-129.

**See Also**

[re\\_gum](#)

**Examples**

```
p <- c(1.8, 2.2)
rlse_gum(p, 4, 2)
rlre_gum(p, 4, 2, 2)
rlhce_gum(p, 4, 2, 2)
rlae_gum(p, 4, 2, 2)
```

---

 Truncated inverse-gamma distribution

*Relative loss for various entropy measures using the truncated inverse-gamma distribution*

---

**Description**

Compute the relative information loss of the Shannon, Rényi, Havrda and Charvat, and Arimoto entropies of the truncated inverse-gamma distribution.

**Usage**

```
rlse_ig(p, alpha, beta)
rlre_ig(p, alpha, beta, delta)
rlhce_ig(p, alpha, beta, delta)
rlae_ig(p, alpha, beta, delta)
```

**Arguments**

alpha	The strictly positive shape parameter of the inverse-gamma distribution ( $\alpha > 0$ ).
beta	The strictly positive scale parameter of the inverse-gamma distribution ( $\beta > 0$ ).
p	The truncation time ( $p > 0$ ).
delta	The strictly positive parameter ( $\delta > 0$ ) and ( $\delta \neq 1$ ).

**Value**

The functions `rlse_ig`, `rlre_ig`, `rlhce_ig`, and `rlae_ig` provide the relative information loss based on the Shannon entropy, Rényi entropy, Havrda and Charvat entropy, and Arimoto entropy, respectively, depending on the selected parametric values of the truncated inverse-gamma distribution,  $p$  and  $\delta$ .

**Author(s)**

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**References**

Awad, A. M., & Alawneh, A. J. (1987). Application of entropy to a life-time model. *IMA Journal of Mathematical Control and Information*, 4(2), 143-148.

Rivera, P. A., Calderín-Ojeda, E., Gallardo, D. I., & Gómez, H. W. (2021). A compound class of the inverse Gamma and power series distributions. *Symmetry*, 13(8), 1328.

**See Also**

[re\\_ig](#)

**Examples**

```
p <- c(1.25, 1.50)
rlse_ig(p, 1.2, 0.2)
rlre_ig(p, 1.2, 0.2, 0.5)
rlhce_ig(p, 1.2, 0.2, 0.5)
rlae_ig(p, 1.2, 0.2, 0.5)
```

---

Truncated Kumaraswamy distribution

*Relative loss for various entropy measures using the truncated Kumaraswamy distribution*

---

**Description**

Compute the relative information loss of the Shannon, Rényi, Havrda and Charvat, and Arimoto entropies of the truncated Kumaraswamy distribution.

**Usage**

```
rlse_kum(p, alpha, beta)
rlre_kum(p, alpha, beta, delta)
rlhce_kum(p, alpha, beta, delta)
rlae_kum(p, alpha, beta, delta)
```

**Arguments**

alpha	The strictly positive shape parameter of the Kumaraswamy distribution ( $\alpha > 0$ ).
beta	The strictly positive shape parameter of the Kumaraswamy distribution ( $\beta > 0$ ).
p	The truncation time ( $p > 0$ ).
delta	The strictly positive parameter ( $\delta > 0$ ) and ( $\delta \neq 1$ ).

**Value**

The functions `rlse_kum`, `rlre_kum`, `rlhce_kum`, and `rlae_kum` provide the relative information loss based on the Shannon entropy, Rényi entropy, Havrda and Charvat entropy, and Arimoto entropy, respectively, depending on the selected parametric values of the truncated Kumaraswamy distribution,  $p$  and  $\delta$ .

**Author(s)**

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**References**

- Awad, A. M., & Alawneh, A. J. (1987). Application of entropy to a life-time model. *IMA Journal of Mathematical Control and Information*, 4(2), 143-148.
- El-Sherpieny, E. S. A., & Ahmed, M. A. (2014). On the Kumaraswamy distribution. *International Journal of Basic and Applied Sciences*, 3(4), 372.
- Al-Babtain, A. A., Elbatal, I., Chesneau, C., & Elgarhy, M. (2021). Estimation of different types of entropies for the Kumaraswamy distribution. *PLoS One*, 16(3), e0249027.

**See Also**

[re\\_kum](#)

**Examples**

```
p <- c(0.25, 0.50, 0.75)
rlse_kum(p, 0.2, 0.4)
rlre_kum(p, 0.2, 0.4, 0.5)
rlhce_kum(p, 0.2, 0.4, 0.5)
rlae_kum(p, 0.2, 0.4, 0.5)
```

---

Truncated Laplace distribution

*Relative loss for various entropy measures using the truncated Laplace distribution*

---

**Description**

Compute the relative information loss of the Shannon, Rényi, Havrda and Charvat, and Arimoto entropies of the truncated Laplace distribution.

**Usage**

```
rlse_lap(p, alpha, beta)
rlre_lap(p, alpha, beta, delta)
rlhce_lap(p, alpha, beta, delta)
rlae_lap(p, alpha, beta, delta)
```

**Arguments**

alpha	Location parameter of the Laplace distribution ( $\alpha \in (-\infty, +\infty)$ ).
beta	The strictly positive scale parameter of the Laplace distribution ( $\beta > 0$ ).
p	The truncation time ( $p > 0$ ).
delta	The strictly positive parameter ( $\delta > 0$ ) and ( $\delta \neq 1$ ).

**Value**

The functions `rlse_lap`, `rlre_lap`, `rlhce_lap`, and `rlae_lap` provide the relative information loss based on the Shannon entropy, Rényi entropy, Havrda and Charvat entropy, and Arimoto entropy, respectively, depending on the selected parametric values of the truncated Laplace distribution,  $p$  and  $\delta$ .

**Author(s)**

Muhammad Imran, Christophe Chesneau and Farrukh Jamal

R implementation and documentation: Muhammad Imran <imranshako0r84@yahoo.com>, Christophe Chesneau <christophe.chesneau@unicaen.fr> and Farrukh Jamal <farrukh.jamal@iub.edu.pk>.

**References**

Awad, A. M., & Alawneh, A. J. (1987). Application of entropy to a life-time model. *IMA Journal of Mathematical Control and Information*, 4(2), 143-148.

Cordeiro, G. M., & Lemonte, A. J. (2011). The beta Laplace distribution. *Statistics & Probability Letters*, 81(8), 973-982.

**See Also**

[re\\_lap](#)

**Examples**

```
p <- c(0.25, 0.50, 0.75)
rlse_lap(p, 0.2, 0.4)
rlre_lap(p, 0.2, 0.4, 0.5)
rlhce_lap(p, 0.2, 0.4, 0.5)
rlae_lap(p, 0.2, 0.4, 0.5)
```

---

Truncated Nakagami distribution

*Relative loss for various entropy measures using the truncated Nakagami distribution*

---

**Description**

Compute the relative information loss of the Shannon, Rényi, Havrda and Charvat, and Arimoto entropies of the truncated Nakagami distribution.

**Usage**

```
rlse_naka(p, alpha, beta)
rlre_naka(p, alpha, beta, delta)
rlhce_naka(p, alpha, beta, delta)
rlae_naka(p, alpha, beta, delta)
```

**Arguments**

alpha	The strictly positive scale parameter of the Nakagami distribution ( $\alpha > 0$ ).
beta	The strictly positive shape parameter of the Nakagami distribution ( $\beta > 0$ ).
p	The truncation time ( $p > 0$ ).
delta	The strictly positive parameter ( $\delta > 0$ ) and ( $\delta \neq 1$ ).

**Value**

The functions `r1se_naka`, `r1re_naka`, `r1hce_naka`, and `r1lae_naka` provide the relative information loss based on the Shannon entropy, Rényi entropy, Havrda and Charvat entropy, and Arimoto entropy, respectively, depending on the selected parametric values of the truncated Nakagami distribution,  $p$  and  $\delta$ .

**Author(s)**

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**References**

Awad, A. M., & Alawneh, A. J. (1987). Application of entropy to a life-time model. *IMA Journal of Mathematical Control and Information*, 4(2), 143-148.

Schwartz, J., Godwin, R. T., & Giles, D. E. (2013). Improved maximum-likelihood estimation of the shape parameter in the Nakagami distribution. *Journal of Statistical Computation and Simulation*, 83(3), 434-445.

**See Also**

[re\\_naka](#)

**Examples**

```
p <- c(1.25, 1.50, 1.75)
r1se_naka(p, 0.2, 1)
r1re_naka(p, 0.2, 1, 0.5)
r1hce_naka(p, 0.2, 1, 0.5)
r1lae_naka(p, 0.2, 1, 0.5)
```

---

Truncated normal distribution

*Relative loss for various entropy measures using the truncated normal distribution*

---

### Description

Compute the relative information loss of the Shannon, Rényi, Havrda and Charvat, and Arimoto entropies of the truncated normal distribution.

### Usage

```
rlse_norm(p, alpha, beta)
rlre_norm(p, alpha, beta, delta)
rlhce_norm(p, alpha, beta, delta)
rlae_norm(p, alpha, beta, delta)
```

### Arguments

alpha	The location parameter of the normal distribution ( $\alpha \in (-\infty, +\infty)$ ).
beta	The strictly positive scale parameter of the normal distribution ( $\beta > 0$ ).
p	The truncation time ( $p > 0$ ).
delta	The strictly positive parameter ( $\delta > 0$ ) and ( $\delta \neq 1$ ).

### Value

The functions `rlse_norm`, `rlre_norm`, `rlhce_norm`, and `rlae_norm` provide the relative information loss based on the Shannon entropy, Rényi entropy, Havrda and Charvat entropy, and Arimoto entropy, respectively, depending on the selected parametric values of the truncated normal distribution,  $p$  and  $\delta$ .

### Author(s)

Muhammad Imran, Christophe Chesneau and Farrukh Jamal

R implementation and documentation: Muhammad Imran <imranshako0r84@yahoo.com>, Christophe Chesneau <christophe.chesneau@unicaen.fr> and Farrukh Jamal <farrukh.jamal@iub.edu.pk>.

### References

Awad, A. M., & Alawneh, A. J. (1987). Application of entropy to a life-time model. *IMA Journal of Mathematical Control and Information*, 4(2), 143-148.

Patel, J. K., & Read, C. B. (1996). *Handbook of the normal distribution* (Vol. 150). CRC Press.

### See Also

[re\\_norm](#)

**Examples**

```
p <- c(0.25, 0.50, 0.75)
rlse_norm(p, 0.2, 1)
rlre_norm(p, 0.2, 1, 0.5)
rlhce_norm(p, 0.2, 1, 0.5)
rlae_norm(p, 0.2, 1, 0.5)
```

---

**Truncated Rayleigh distribution**

*Relative loss for various entropy measures using the truncated Rayleigh distribution*

---

**Description**

Compute the relative information loss of the Shannon, Rényi, Havrda and Charvat, and Arimoto entropies of the truncated Rayleigh distribution.

**Usage**

```
rlse_ray(p, alpha)
rlre_ray(p, alpha, delta)
rlhce_ray(p, alpha, delta)
rlae_ray(p, alpha, delta)
```

**Arguments**

alpha	The strictly positive scale parameter of the Rayleigh distribution ( $\alpha > 0$ ).
p	The truncation time ( $p > 0$ ).
delta	The strictly positive parameter ( $\delta > 0$ ) and ( $\delta \neq 1$ ).

**Value**

The functions `rlse_ray`, `rlre_ray`, `rlhce_ray`, and `rlae_ray` provide the relative information loss based on the Shannon entropy, Rényi entropy, Havrda and Charvat entropy, and Arimoto entropy, respectively, depending on the selected parametric values of the truncated Rayleigh distribution,  $p$  and  $\delta$ .

**Author(s)**

Muhammad Imran, Christophe Chesneau and Farrukh Jamal

R implementation and documentation: Muhammad Imran <imranshako0r84@yahoo.com>, Christophe Chesneau <christophe.chesneau@unicaen.fr> and Farrukh Jamal <farrukh.jamal@iub.edu.pk>.

**References**

- Dey, S., Maiti, S. S., & Ahmad, M. (2016). Comparison of different entropy measures. *Pak. J. Statist*, 32(2), 97-108.
- Awad, A. M., & Alawneh, A. J. (1987). Application of entropy to a life-time model. *IMA Journal of Mathematical Control and Information*, 4(2), 143-148.

**See Also**

[re\\_ray](#)

**Examples**

```
p <- seq(0.25, 2, by=0.25)
rlse_ray(p, 2)
rlre_ray(p, 2, 0.5)
rlhce_ray(p, 2, 0.5)
rlae_ray(p, 2, 0.5)

# A graphic representation of relative loss (RL)
library(ggplot2)
# p is a truncation time vector
p <- seq(0.25, 2, by = 0.25)
# RL based on the Rényi entropy
z1 <- rlre_ray(p, 0.1, 0.5)
# RL based on the Havrda and Charvat entropy
z2 <- rlhce_ray(p, 0.1, 0.5)
# RL based on the Arimoto entropy
z3 <- rlae_ray(p, 0.1, 0.5)
# RL based on the Shannon entropy
z4 <- rlse_ray(p, 0.1)
df <- data.frame(x = p, RL = z1, z2, z3, z4)
head(df)
p1 <- ggplot(df, aes(x = p, y = RL, color = Entropy))
p1 + geom_line(aes(colour = "RE"), size = 1) + geom_line(aes(x,
  y = z2, colour = "HCE"), size = 1) + geom_line(aes(x, y = z3,
  colour = "AR"), size = 1) + geom_line(aes(x, y = z4, colour = "SE"),
  size = 1) + ggtitle(expression(delta == 0.5 ~ ~alpha == 0.1))
```

---

Truncated Student's *t* distribution

*Relative loss for various entropy measures using the truncated Student's *t* distribution*

---

**Description**

Compute the relative information loss of the Shannon, Rényi, Havrda and Charvat, and Arimoto entropies of the truncated Student's *t* distribution.

**Usage**

```
rlse_st(p, v)
rlre_st(p, v, delta)
rlhce_st(p, v, delta)
rlae_st(p, v, delta)
```

**Arguments**

<code>v</code>	The strictly positive parameter of the Student distribution ( $v > 0$ ), also called a degree of freedom.
<code>p</code>	The truncation time ( $p > 0$ ).
<code>delta</code>	The strictly positive parameter ( $\delta > 0$ ) and ( $\delta \neq 1$ ).

**Value**

The functions `rlse_st`, `rlre_st`, `rlhce_st`, and `rlae_st` provide the relative information loss based on the Shannon entropy, Rényi entropy, Havrda and Charvat entropy, and Arimoto entropy, respectively, depending on the selected parametric values of the truncated Student's  $t$  distribution,  $p$  and  $\delta$ .

**Author(s)**

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**References**

Yang, Z., Fang, K. T., & Kotz, S. (2007). On the Student's  $t$ -distribution and the  $t$ -statistic. *Journal of Multivariate Analysis*, 98(6), 1293-1304.

Awad, A. M., & Alawneh, A. J. (1987). Application of entropy to a life-time model. *IMA Journal of Mathematical Control and Information*, 4(2), 143-148.

**See Also**

[re\\_st](#)

**Examples**

```
p <- c(1, 1.7, 3)
rlse_st(p, 4)
rlre_st(p, 4, 0.5)
rlhce_st(p, 4, 0.5)
rlae_st(p, 4, 0.5)
```

---

Truncated Weibull distribution

*Relative loss for various entropy measures using the truncated Weibull distribution*

---

### Description

Compute the relative information loss of the Shannon, Rényi, Havrda and Charvat, and Arimoto entropies of the truncated Weibull distribution.

### Usage

```
rlse_wei(p, alpha, beta)
rlre_wei(p, alpha, beta, delta)
rlhce_wei(p, alpha, beta, delta)
rlae_wei(p, alpha, beta, delta)
```

### Arguments

alpha	The strictly positive scale parameter of the Weibull distribution ( $\alpha > 0$ ).
beta	The strictly positive shape parameter of the Weibull distribution ( $\beta > 0$ ).
p	The truncation time ( $p > 0$ ).
delta	The strictly positive parameter ( $\delta > 0$ ) and ( $\delta \neq 1$ ).

### Value

The functions `rlse_wei`, `rlre_wei`, `rlhce_wei`, and `rlae_wei` provide the relative information loss based on the Shannon entropy, Rényi entropy, Havrda and Charvat entropy, and Arimoto entropy, respectively, depending on the selected parametric values of the truncated Weibull distribution,  $p$  and  $\delta$ .

### Author(s)

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### References

Awad, A. M., & Alawneh, A. J. (1987). Application of entropy to a life-time model. *IMA Journal of Mathematical Control and Information*, 4(2), 143-148.

Weibull, W. (1951). A statistical distribution function of wide applicability. *Journal of applied mechanics*, 18, 293-297.

### See Also

[re\\_wei](#)

**Examples**

```
p <- c(1, 1.7, 3)
rlse_wei(p, 2, 1)
rlre_wei(p, 2, 1, 0.5)
rlhce_wei(p, 2, 1, 0.5)
rlae_wei(p, 2, 1, 0.5)
```

---

Weibull distribution    *Compute the Shannon, Rényi, Havrda and Charvat, and Arimoto entropies of the Weibull distribution*

---

**Description**

Compute the Shannon, Rényi, Havrda and Charvat, and Arimoto entropies of the Weibull distribution.

**Usage**

```
se_wei(alpha, beta)
re_wei(alpha, beta, delta)
hce_wei(alpha, beta, delta)
ae_wei(alpha, beta, delta)
```

**Arguments**

alpha	The strictly positive scale parameter of the Weibull distribution ( $\alpha > 0$ ).
beta	The strictly positive shape parameter of the Weibull distribution ( $\beta > 0$ ).
delta	The strictly positive parameter ( $\delta > 0$ ) and ( $\delta \neq 1$ ).

**Details**

The following is the probability density function of the Weibull distribution:

$$f(x) = \frac{\beta}{\alpha} \left(\frac{x}{\alpha}\right)^{\beta-1} e^{-\left(\frac{x}{\alpha}\right)^\beta},$$

where  $x > 0$ ,  $\alpha > 0$  and  $\beta > 0$ .

**Value**

The functions `se_wei`, `re_wei`, `hce_wei`, and `ae_wei` provide the Shannon entropy, Rényi entropy, Havrda and Charvat entropy, and Arimoto entropy, respectively, depending on the selected parametric values of the Weibull distribution and  $\delta$ .

**Author(s)**

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R implementation and documentation: Muhammad Imran <imranshako0r84@yahoo.com>, Christophe Chesneau <christophe.chesneau@unicaen.fr> and Farrukh Jamal <farrukh.jamal@iub.edu.pk>.

### References

Weibull, W. (1951). A statistical distribution function of wide applicability. *Journal of applied mechanics*, 18, 293-297.

### See Also

[re\\_exp](#), [re\\_gamma](#), [re\\_ee](#)

### Examples

```
se_wei(1.2, 0.2)
delta <- c(1.5, 2, 3)
re_wei(1.2, 0.2, delta)
hce_wei(1.2, 0.2, delta)
ae_wei(1.2, 0.2, delta)
```

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