Package ‘shannon’

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Type Package

Title Computation of Entropy Measures and Relative Loss

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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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Contents

shannon-package *Computation of Entropy Measures and Relative Loss*

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 Shahnon entropy is as follows:

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

The Rényi entropy is as follows:

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

The Havrda and Charvat entropy is as follows:

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

The Arimoto entropy is as follows:

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

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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Maintainers

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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 α-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 δ.

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:

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

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 δ.

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., & 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 δ.

Author(s)

Muhammad Imran, Christophe Chesneau and Farrukh Jamal

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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:

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

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 δ.

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 δ.

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, 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 δ.

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

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 δ.

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., & Haghighi, 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:

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

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 δ.

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. (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 δ.

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

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:

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

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 δ.

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)
```

Frechet 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:

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

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 distribution and δ.

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

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

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 δ.

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

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:

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

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 δ.

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-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_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 δ.

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 δ.

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

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:

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

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 δ.

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:

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

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 δ.

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., & 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:

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

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 δ.

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., & 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 distributiondistribution*

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 δ.

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 δ.

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 δ.

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_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 — *Compute the Shannon, Rényi, Havrda and Charvat, and Arimoto entropies of the Lomax distribution*

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 δ.

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

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 δ.

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 α and β 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 δ.

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 δ.

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 δ.

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

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 δ.

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

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 δ.

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 δ.

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.

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 δ.

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 δ.

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 δ.

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. 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 δ.

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 δ.

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 δ.

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.

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 δ.

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.

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 δ.

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.

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 δ.

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.

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 rlse_naka, rlre_naka, rlhce_naka, and rlae_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 δ.

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.

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)
rlse_naka(p, 0.2, 1)
rlre_naka(p, 0.2, 1, 0.5)
rlhce_naka(p, 0.2, 1, 0.5)
rlae_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 δ.

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

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 δ.

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.

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

v	The strictly positive parameter of the Student distribution ($v > 0$), also called a degree of freedom.
p	The truncation time ($p > 0$).
delta	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 δ.

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

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 δ.

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.

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:

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

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 δ.

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

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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