Package ‘VaRES’

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Title Computes Value at Risk and Expected Shortfall for over 100 Parametric Distributions

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Description Computes Value at risk and expected shortfall, two most popular measures of financial risk, for over one hundred parametric distributions, including all commonly known distributions. Also computed are the corresponding probability density function and cumulative distribution function. See Chan, Nadarajah and Afuecheta (2015) <doi:10.1080/03610918.2014.944658> for more details.

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NeedsCompilation no

BugReports https://github.com/lbelzile/VaRES/issues/

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`VaRES-package` *Computes value at risk and expected shortfall for over 100 parametric distributions*

Description

Computes Value at risk and expected shortfall, two most popular measures of financial risk, for over one hundred parametric distributions, including all commonly known distributions. Also computed are the corresponding probability density function and cumulative distribution function.

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

`aep` *Asymmetric exponential power distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the asymmetric exponential power distribution due to Zhu and Zinde-Walsh (2009) given by

$$f(x)=\begin{cases}\frac{\alpha}{\alpha^*}K(q_1)\exp\left[-\frac{1}{q_1}\left|\frac{x}{2\alpha^*}\right|^{q_1}\right], & \text{if } x\le 0,\\ \frac{1-\alpha}{1-\alpha^*}K(q_2)\exp\left[-\frac{1}{q_2}\left|\frac{x}{2-2\alpha^*}\right|^{q_2}\right], & \text{if } x>0,\end{cases}$$

$$F(x)=\begin{cases}\alpha Q\left(\frac{1}{q_1}\left(\frac{\mid x\mid}{2\alpha^*}\right)^{q_1},\frac{1}{q_1}\right), & \text{if } x\le 0,\\ 1-(1-\alpha)Q\left(\frac{1}{q_2}\left(\frac{\mid x\mid}{2-2\alpha^*}\right)^{q_2},\frac{1}{q_2}\right), & \text{if } x>0,\end{cases}$$

$$\mathrm{VaR}_p(X)=\begin{cases}-2\alpha^*\left[q_1Q^{-1}\left(\frac{p}{\alpha},\frac{1}{q_1}\right)\right]^{\frac{1}{q_1}}, & \text{if } p\le\alpha,\\ 2(1-\alpha^*)\left[q_2Q^{-1}\left(\frac{1-p}{1-\alpha},\frac{1}{q_2}\right)\right]^{\frac{1}{q_2}}, & \text{if } p>\alpha,\end{cases}$$

$$\mathrm{ES}_p(X)=\begin{cases}-\frac{2\alpha^*}{p}\int_0^p\left[q_1Q^{-1}\left(\frac{v}{\alpha},\frac{1}{q_1}\right)\right]^{\frac{1}{q_1}}dv, & \text{if } p\le\alpha,\\ -\frac{2\alpha^*}{p}\int_0^\alpha\left[q_1Q^{-1}\left(\frac{v}{\alpha},\frac{1}{q_1}\right)\right]^{\frac{1}{q_1}}dv \\ \quad+\frac{2(1-\alpha^*)}{p}\int_\alpha^p\left[q_2Q^{-1}\left(\frac{1-v}{1-\alpha},\frac{1}{q_2}\right)\right]^{\frac{1}{q_2}}dv, & \text{if } p>\alpha\end{cases}$$

for $-\infty < x < \infty$, $0 < p < 1$, $0 < \alpha < 1$, the scale parameter, $q_1 > 0$, the first shape parameter, and $q_2 > 0$, the second shape parameter, where $\alpha^* = \alpha K(q_1)/\{\alpha K(q_1) + (1-\alpha)K(q_2)\}$, $K(q) = \frac{1}{2q^{1/q}\Gamma(1+1/q)}$, $Q(a,x) = \int_x^\infty t^{a-1}\exp(-t)\,dt/\Gamma(a)$ denotes the regularized complementary incomplete gamma function, $\Gamma(a) = \int_0^\infty t^{a-1}\exp(-t)\,dt$ denotes the gamma function, and $Q^{-1}(a,x)$ denotes the inverse of $Q(a,x)$.

Usage

```
daep(x, q1=1, q2=1, alpha=0.5, log=FALSE)
paep(x, q1=1, q2=1, alpha=0.5, log.p=FALSE, lower.tail=TRUE)
varaep(p, q1=1, q2=1, alpha=0.5, log.p=FALSE, lower.tail=TRUE)
esaep(p, q1=1, q2=1, alpha=0.5)
```

Arguments

`x`	scaler or vector of values at which the pdf or cdf needs to be computed
`p`	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
`alpha`	the value of the scale parameter, must be in the unit interval, the default is 0.5

`q1`	the value of the first shape parameter, must be positive, the default is 1
`q2`	the value of the second shape parameter, must be positive, the default is 1
`log`	if TRUE then log(pdf) are returned
`log.p`	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
`lower.tail`	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as `x`, giving the pdf or cdf values computed at `x` or an object of the same length as `p`, giving the values at risk or expected shortfall computed at `p`.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
daep(x)
paep(x)
varaep(x)
esaep(x)
```

`arcsine` *Arcsine distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the arcsine distribution given by

$$f(x) = \frac{1}{\pi \sqrt{(x-a)(b-x)}},$$
$$F(x) = \frac{2}{\pi} \arcsin\left(\sqrt{\frac{x-a}{b-a}}\right),$$
$$\mathrm{VaR}_p(X) = a + (b-a)\sin^2\left(\frac{\pi p}{2}\right),$$
$$\mathrm{ES}_p(X) = a + \frac{b-a}{p}\int_0^p \sin^2\left(\frac{\pi v}{2}\right) dv$$

for $a \leq x \leq b$, $0 < p < 1$, $-\infty < a < \infty$, the first location parameter, and $-\infty < a < b < \infty$, the second location parameter.

Usage

```
darcsine(x, a=0, b=1, log=FALSE)
parcsine(x, a=0, b=1, log.p=FALSE, lower.tail=TRUE)
vararcsine(p, a=0, b=1, log.p=FALSE, lower.tail=TRUE)
esarcsine(p, a=0, b=1)
```

Arguments

`x`	scaler or vector of values at which the pdf or cdf needs to be computed
`p`	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
`a`	the value of the first location parameter, can take any real value, the default is zero
`b`	the value of the second location parameter, can take any real value but must be greater than a, the default is 1
`log`	if TRUE then log(pdf) are returned
`log.p`	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
`lower.tail`	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as `x`, giving the pdf or cdf values computed at `x` or an object of the same length as `p`, giving the values at risk or expected shortfall computed at `p`.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
darcsine(x)
parcsine(x)
vararcsine(x)
esarcsine(x)
```

ast *Generalized asymmetric Student's t distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the generalized asymmetric Student's t distribution due to Zhu and Galbraith (2010) given by

$$f(x) = \begin{cases} \frac{\alpha}{\alpha^*} K(\nu_1) \left[1 + \frac{1}{\nu_1} \left(\frac{x}{2\alpha^*} \right)^2 \right]^{-\frac{\nu_1+1}{2}}, & \text{if } x \le 0, \\ \frac{1-\alpha}{1-\alpha^*} K(\nu_2) \left[1 + \frac{1}{\nu_2} \left(\frac{x}{2(1-\alpha^*)} \right)^2 \right]^{-\frac{\nu_2+1}{2}}, & \text{if } x > 0, \end{cases}$$

$$F(x) = 2\alpha F_{\nu_1}\left(\frac{\min(x,0)}{2\alpha^*} \right) - 1 + \alpha + 2(1-\alpha) F_{\nu_2}\left(\frac{\max(x,0)}{2 - 2\alpha^*} \right),$$

$$\mathrm{VaR}_p(X) = 2\alpha^* F_{\nu_1}^{-1}\left(\frac{\min(p,\alpha)}{2\alpha} \right) + 2(1-\alpha^*) F_{\nu_2}^{-1}\left(\frac{\max(p,\alpha) + 1 - 2\alpha}{2 - 2\alpha} \right),$$

$$\mathrm{ES}_p(X) = \frac{2\alpha^*}{p} \int_0^p F_{\nu_1}^{-1}\left(\frac{\min(v,\alpha)}{2\alpha} \right) dv + \frac{2(1-\alpha^*)}{p} \int_0^p F_{\nu_2}^{-1}\left(\frac{\max(v,\alpha) + 1 - 2\alpha}{2 - 2\alpha} \right) dv$$

for $-\infty < x < \infty$, $0 < p < 1$, $0 < \alpha < 1$, the scale parameter, $\nu_1 > 0$, the first degree of freedom parameter, and $\nu_2 > 0$, the second degree of freedom parameter, where $\alpha^* = \alpha K(\nu_1) / \{\alpha K(\nu_1) + (1-\alpha) K(\nu_2)\}$, $K(\nu) = \Gamma((\nu+1)/2) / [\sqrt{\pi\nu}\Gamma(\nu/2)]$, $F_\nu(\cdot)$ denotes the cdf of a Student's t random variable with ν degrees of freedom, and $F_\nu^{-1}(\cdot)$ denotes the inverse of $F_\nu(\cdot)$.

Usage

```
dast(x, nu1=1, nu2=1, alpha=0.5, log=FALSE)
past(x, nu1=1, nu2=1, alpha=0.5, log.p=FALSE, lower.tail=TRUE)
varast(p, nu1=1, nu2=1, alpha=0.5, log.p=FALSE, lower.tail=TRUE)
esast(p, nu1=1, nu2=1, alpha=0.5)
```

Arguments

`x`	scaler or vector of values at which the pdf or cdf needs to be computed
`p`	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
`alpha`	the value of the scale parameter, must be in the unit interval, the default is 0.5
`nu1`	the value of the first degree of freedom parameter, must be positive, the default is 1
`nu2`	the value of the second degree of freedom parameter, must be positive, the default is 1
`log`	if TRUE then log(pdf) are returned
`log.p`	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
`lower.tail`	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as x, giving the pdf or cdf values computed at x or an object of the same length as p, giving the values at risk or expected shortfall computed at p.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dast(x)
past(x)
varast(x)
esast(x)
```

---

asylaplace *Asymmetric Laplace distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the asymmetric Laplace distribution due to Kotz et al. (2001) given by

$$f(x) = \begin{cases} \dfrac{\kappa\sqrt{2}}{\tau\left(1+\kappa^2\right)} \exp\left(-\dfrac{\kappa\sqrt{2}}{\tau}\left|x-\theta\right|\right), & \text{if } x \geq \theta, \\ \\ \dfrac{\kappa\sqrt{2}}{\tau\left(1+\kappa^2\right)} \exp\left(-\dfrac{\sqrt{2}}{\kappa\tau}\left|x-\theta\right|\right), & \text{if } x < \theta, \end{cases}$$

$$F(x) = \begin{cases} 1 - \dfrac{1}{1+\kappa^2} \exp\left(\dfrac{\kappa\sqrt{2}(\theta-x)}{\tau}\right), & \text{if } x \geq \theta, \\ \\ \dfrac{\kappa^2}{1+\kappa^2} \exp\left(\dfrac{\sqrt{2}(x-\theta)}{\kappa\tau}\right), & \text{if } x < \theta, \end{cases}$$

$$\mathrm{VaR}_p(X) = \begin{cases} \theta - \dfrac{\tau}{\sqrt{2}\kappa} \log\left[(1-p)\left(1+\kappa^2\right)\right], & \text{if } p \geq \frac{\kappa^2}{1+\kappa^2}, \\ \\ \theta + \dfrac{\kappa\tau}{\sqrt{2}} \log\left[p\left(1+\kappa^{-2}\right)\right], & \text{if } p < \frac{\kappa^2}{1+\kappa^2}, \end{cases}$$

$$\mathrm{ES}_p(X) = \begin{cases} \dfrac{\theta}{p} + \theta - \dfrac{\tau}{\sqrt{2}\kappa} \log\left(1+\kappa^2\right) + \dfrac{\sqrt{2}\tau\left(1+2\kappa^2\right)}{2\kappa\left(1+\kappa^2\right)p} \log\left(1+\kappa^2\right) \\ \quad - \dfrac{\sqrt{2}\tau\kappa\log\kappa}{\left(1+\kappa^2\right)p} - \dfrac{\theta\kappa^2}{\left(1+\kappa^2\right)p} + \dfrac{\tau\left(1-\kappa^4\right)}{\sqrt{2}\kappa\left(1+\kappa^2\right)p} \\ \quad - \dfrac{\tau(1-p)}{\sqrt{2}\kappa p} + \dfrac{\tau(1-p)}{\sqrt{2}\kappa p}\log(1-p), & \text{if } p \geq \frac{\kappa^2}{1+\kappa^2}, \\ \\ \theta + \dfrac{\kappa\tau}{\sqrt{2}} \log\left(1+\kappa^{-2}\right) + \dfrac{\kappa\tau}{\sqrt{2}}(\log p - 1), & \text{if } p < \frac{\kappa^2}{1+\kappa^2} \end{cases}$$

for $-\infty < x < \infty$, $0 < p < 1$, $-\infty < \theta < \infty$, the location parameter, $\kappa > 0$, the first scale parameter, and $\tau > 0$, the second scale parameter.

Usage

```
dasylaplace(x, tau=1, kappa=1, theta=0, log=FALSE)
pasylaplace(x, tau=1, kappa=1, theta=0, log.p=FALSE, lower.tail=TRUE)
varasylaplace(p, tau=1, kappa=1, theta=0, log.p=FALSE, lower.tail=TRUE)
esasylaplace(p, tau=1, kappa=1, theta=0)
```

Arguments

`x`	scaler or vector of values at which the pdf or cdf needs to be computed
`p`	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
`theta`	the value of the location parameter, can take any real value, the default is zero
`kappa`	the value of the first scale parameter, must be positive, the default is 1

tau	the value of the second scale parameter, must be positive, the default is 1
log	if TRUE then log(pdf) are returned
log.p	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
lower.tail	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as x, giving the pdf or cdf values computed at x or an object of the same length as p, giving the values at risk or expected shortfall computed at p.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dasylaplace(x)
pasylaplace(x)
varasylaplace(x)
esasylaplace(x)
```

---

asypower *Asymmetric power distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the asymmetric power distribution due to Komunjer (2007) given by

$$f(x) = \begin{cases} \dfrac{\delta^{1/\lambda}}{\Gamma(1+1/\lambda)} \exp\left[-\dfrac{\delta}{a^\lambda}|x|^\lambda\right], & \text{if } x \le 0, \\ \dfrac{\delta^{1/\lambda}}{\Gamma(1+1/\lambda)} \exp\left[-\dfrac{\delta}{(1-a)^\lambda}|x|^\lambda\right], & \text{if } x > 0, \end{cases}$$

$$F(x) = \begin{cases} a - a\mathcal{I}\left(\dfrac{\delta}{a^\lambda}\sqrt{\lambda}|x|^\lambda, 1/\lambda\right), & \text{if } x \le 0, \\ a - (1-a)\mathcal{I}\left(\dfrac{\delta}{(1-a)^\lambda}\sqrt{\lambda}|x|^\lambda, 1/\lambda\right), & \text{if } x > 0, \end{cases}$$

$$\mathrm{VaR}_p(X) = \begin{cases} -\left[\dfrac{a^\lambda}{\delta\sqrt{\lambda}}\right]^{1/\lambda}\left[\mathcal{I}^{-1}\left(1-\dfrac{p}{a}, \dfrac{1}{\lambda}\right)\right]^{1/\lambda}, & \text{if } p \le a, \\ -\left[\dfrac{(1-a)^\lambda}{\delta\sqrt{\lambda}}\right]^{1/\lambda}\left[\mathcal{I}^{-1}\left(1-\dfrac{1-p}{1-a}, \dfrac{1}{\lambda}\right)\right]^{1/\lambda}, & \text{if } p > a, \end{cases}$$

$$\mathrm{ES}_p(X) = \begin{cases} -\dfrac{1}{p}\left[\dfrac{a^\lambda}{\delta\sqrt{\lambda}}\right]^{1/\lambda}\displaystyle\int_0^p\left[\mathcal{I}^{-1}\left(1-\dfrac{v}{a}, \dfrac{1}{\lambda}\right)\right]^{1/\lambda} dv, & \text{if } p \le a, \\ -\dfrac{1}{p}\left[\dfrac{a^\lambda}{\delta\sqrt{\lambda}}\right]^{1/\lambda}\displaystyle\int_0^a\left[\mathcal{I}^{-1}\left(1-\dfrac{v}{a}, \dfrac{1}{\lambda}\right)\right]^{1/\lambda} dv & \\ \quad -\dfrac{1}{p}\left[\dfrac{(1-a)^\lambda}{\delta\sqrt{\lambda}}\right]^{1/\lambda}\displaystyle\int_a^p\left[\mathcal{I}^{-1}\left(1-\dfrac{1-v}{1-a}, \dfrac{1}{\lambda}\right)\right]^{1/\lambda} dv, & \text{if } p > a \end{cases}$$

for $-\infty < x < \infty$, $0 < p < 1$, $0 < a < 1$, the first scale parameter, $\delta > 0$, the second scale parameter, and $\lambda > 0$, the shape parameter, where $\mathcal{I}(x,\gamma) = \frac{1}{\Gamma(\gamma)}\int_0^{x\sqrt{\gamma}} t^{\gamma-1}\exp(-t)dt$.

Usage

```
dasypower(x, a=0.5, lambda=1, delta=1, log=FALSE)
pasypower(x, a=0.5, lambda=1, delta=1, log.p=FALSE, lower.tail=TRUE)
varasypower(p, a=0.5, lambda=1, delta=1, log.p=FALSE, lower.tail=TRUE)
esasypower(p, a=0.5, lambda=1, delta=1)
```

Arguments

`x`	scaler or vector of values at which the pdf or cdf needs to be computed
`p`	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
`a`	the value of the first scale parameter, must be in the unit interval, the default is 0.5
`delta`	the value of the second scale parameter, must be positive, the default is 1
`lambda`	the value of the shape parameter, must be positive, the default is 1

`log`	if TRUE then log(pdf) are returned
`log.p`	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
`lower.tail`	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as `x`, giving the pdf or cdf values computed at `x` or an object of the same length as `p`, giving the values at risk or expected shortfall computed at `p`.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dasypower(x)
pasypower(x)
varasypower(x)
esasypower(x)
```

`beard` *Beard distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the Beard distribution due to Beard (1959) given by

$$
\begin{aligned}
f(x) &= \frac{a\exp(bx)\left[1+a\rho\right]^{\rho^{-1/b}}}{\left[1+a\rho\exp(bx)\right]^{1+\rho^{-1/b}}}, \\
F(x) &= 1-\frac{\left[1+a\rho\right]^{\rho^{-1/b}}}{\left[1+a\rho\exp(bx)\right]^{\rho^{-1/b}}}, \\
\mathrm{VaR}_p(X) &= \frac{1}{b}\log\left[\frac{1+a\rho}{a\rho(1-p)^{\rho^{1/b}}}-\frac{1}{a\rho}\right], \\
\mathrm{ES}_p(X) &= \frac{1}{pb}\int_0^p \log\left[-\frac{1}{a\rho}+\frac{1+a\rho}{a\rho(1-v)^{\rho^{1/b}}}\right]dv
\end{aligned}
$$

for $x > 0$, $0 < p < 1$, $a > 0$, the first scale parameter, $b > 0$, the second scale parameter, and $\rho > 0$, the shape parameter.

Usage

```
dbeard(x, a=1, b=1, rho=1, log=FALSE)
pbeard(x, a=1, b=1, rho=1, log.p=FALSE, lower.tail=TRUE)
varbeard(p, a=1, b=1, rho=1, log.p=FALSE, lower.tail=TRUE)
esbeard(p, a=1, b=1, rho=1)
```

Arguments

x	scaler or vector of values at which the pdf or cdf needs to be computed
p	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
a	the value of the first scale parameter, must be positive, the default is 1
b	the value of the second scale parameter, must be positive, the default is 1
rho	the value of the shape parameter, must be positive, the default is 1
log	if TRUE then log(pdf) are returned
log.p	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
lower.tail	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as x, giving the pdf or cdf values computed at x or an object of the same length as p, giving the values at risk or expected shortfall computed at p.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dbeard(x)
pbeard(x)
varbeard(x)
esbeard(x)
```

betaburr *Beta Burr distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the beta Burr distribution due to Parana\'iba et al. (2011) given by

$$
\begin{array}{l}
f(x) = \displaystyle\frac{b a^{bd}}{B(c,d) x^{bd+1}} \left[1 + (x/a)^{-b} \right]^{-c-d}, \\
F(x) = I_{\frac{1}{1+(x/a)^{-b}}} (c,d), \\
\mathrm{VaR}_p(X) = a \left[I_p^{-1}(c,d) \right]^{1/b} \left[1 - I_p^{-1}(c,d) \right]^{-1/b}, \\
\mathrm{ES}_p(X) = \displaystyle\frac{a}{p} \int_0^p \left[I_v^{-1}(c,d) \right]^{1/b} \left[1 - I_v^{-1}(c,d) \right]^{-1/b} dv
\end{array}
$$

for $x > 0$, $0 < p < 1$, $a > 0$, the scale parameter, $b > 0$, the first shape parameter, $c > 0$, the second shape parameter, and $d > 0$, the third shape parameter, where $I_x(a,b) = \int_0^x t^{a-1}(1-t)^{b-1} dt / B(a,b)$ denotes the incomplete beta function ratio, $B(a,b) = \int_0^1 t^{a-1}(1-t)^{b-1} dt$ denotes the beta function, and $I_x^{-1}(a,b)$ denotes the inverse function of $I_x(a,b)$.

Usage

```
dbetaburr(x, a=1, b=1, c=1, d=1, log=FALSE)
pbetaburr(x, a=1, b=1, c=1, d=1, log.p=FALSE, lower.tail=TRUE)
varbetaburr(p, a=1, b=1, c=1, d=1, log.p=FALSE, lower.tail=TRUE)
esbetaburr(p, a=1, b=1, c=1, d=1)
```

Arguments

`x`	scaler or vector of values at which the pdf or cdf needs to be computed
`p`	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
`a`	the value of the scale parameter, must be positive, the default is 1
`b`	the value of the first shape parameter, must be positive, the default is 1
`c`	the value of the second shape parameter, must be positive, the default is 1
`d`	the value of the third shape parameter, must be positive, the default is 1
`log`	if TRUE then log(pdf) are returned
`log.p`	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
`lower.tail`	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as `x`, giving the pdf or cdf values computed at `x` or an object of the same length as `p`, giving the values at risk or expected shortfall computed at `p`.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dbetaburr(x)
pbetaburr(x)
varbetaburr(x)
esbetaburr(x)
```

---

betaburr7 *Beta Burr XII distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the beta Burr XII distribution given by

$$f(x) = \frac{kcx^{c-1}}{B(a,b)} \left[1 - (1+x^c)^{-k}\right]^{a-1} (1+x^c)^{-bk-1},$$
$$F(x) = I_{1-(1+x^c)^{-k}}(a,b),$$
$$\mathrm{VaR}_p(X) = \left\{\left[1 - I_p^{-1}(a,b)\right]^{-1/k} - 1\right\}^{1/c},$$
$$\mathrm{ES}_p(X) = \frac{1}{p}\int_0^p \left\{\left[1 - I_v^{-1}(a,b)\right]^{-1/k} - 1\right\}^{1/c} dv$$

for $x > 0$, $0 < p < 1$, $a > 0$, the first shape parameter, $b > 0$, the second shape parameter, $c > 0$, the third shape parameter, and $k > 0$, the fourth shape parameter.

Usage

```
dbetaburr7(x, a=1, b=1, c=1, k=1, log=FALSE)
pbetaburr7(x, a=1, b=1, c=1, k=1, log.p=FALSE, lower.tail=TRUE)
varbetaburr7(p, a=1, b=1, c=1, k=1, log.p=FALSE, lower.tail=TRUE)
esbetaburr7(p, a=1, b=1, c=1, k=1)
```

Arguments

x	scaler or vector of values at which the pdf or cdf needs to be computed
p	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
a	the value of the first shape parameter, must be positive, the default is 1

b	the value of the second shape parameter, must be positive, the default is 1
c	the value of the third shape parameter, must be positive, the default is 1
k	the value of the fourth shape parameter, must be positive, the default is 1
log	if TRUE then log(pdf) are returned
log.p	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
lower.tail	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as x, giving the pdf or cdf values computed at x or an object of the same length as p, giving the values at risk or expected shortfall computed at p.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dbetaburr7(x)
pbetaburr7(x)
varbetaburr7(x)
esbetaburr7(x)
```

---

betadist *Beta distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the beta distribution given by

$$\begin{array}{l} f(x) = \dfrac{x^{a-1}(1-x)^{b-1}}{B(a,b)}, \\ F(x) = I_x(a,b), \\ \mathrm{VaR}_p(X) = I_p^{-1}(a,b), \\ \mathrm{ES}_p(X) = \dfrac{1}{p}\displaystyle\int_0^p I_v^{-1}(a,b)dv \end{array}$$

for $0 < x < 1$, $0 < p < 1$, $a > 0$, the first parameter, and $b > 0$, the second shape parameter.

Usage

```
dbetadist(x, a=1, b=1, log=FALSE)
pbetadist(x, a=1, b=1, log.p=FALSE, lower.tail=TRUE)
varbetadist(p, a=1, b=1, log.p=FALSE, lower.tail=TRUE)
esbetadist(p, a=1, b=1)
```

Arguments

`x`	scaler or vector of values at which the pdf or cdf needs to be computed
`p`	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
`a`	the value of the first scale parameter, must be positive, the default is 1
`b`	the value of the second scale parameter, must be positive, the default is 1
`log`	if TRUE then log(pdf) are returned
`log.p`	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
`lower.tail`	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as `x`, giving the pdf or cdf values computed at `x` or an object of the same length as `p`, giving the values at risk or expected shortfall computed at `p`.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dbetadist(x)
pbetadist(x)
varbetadist(x)
esbetadist(x)
```

betaexp *Beta exponential distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the beta exponential distribution due to Nadarajah and Kotz (2006) given by

$$
\begin{aligned}
f(x) &= \frac{\lambda \exp(-b\lambda x)}{B(a,b)} \left[1-\exp(-\lambda x)\right]^{a-1}, \\
F(x) &= I_{1-\exp(-\lambda x)}(a,b), \\
\mathrm{VaR}_p(X) &= -\frac{1}{\lambda} \log\left[1 - I_p^{-1}(a,b)\right], \\
\mathrm{ES}_p(X) &= -\frac{1}{p\lambda} \int_0^p \log\left[1 - I_v^{-1}(a,b)\right] dv
\end{aligned}
$$

for $x > 0$, $0 < p < 1$, $a > 0$, the first shape parameter, $b > 0$, the second shape parameter, and $\lambda > 0$, the scale parameter, where $I_x(a,b) = \int_0^x t^{a-1}(1-t)^{b-1} dt / B(a,b)$ denotes the incomplete beta function ratio, $B(a,b) = \int_0^1 t^{a-1}(1-t)^{b-1} dt$ denotes the beta function, and $I_x^{-1}(a,b)$ denotes the inverse function of $I_x(a,b)$.

Usage

```
dbetaexp(x, lambda=1, a=1, b=1, log=FALSE)
pbetaexp(x, lambda=1, a=1, b=1, log.p=FALSE, lower.tail=TRUE)
varbetaexp(p, lambda=1, a=1, b=1, log.p=FALSE, lower.tail=TRUE)
esbetaexp(p, lambda=1, a=1, b=1)
```

Arguments

`x`	scaler or vector of values at which the pdf or cdf needs to be computed
`p`	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
`lambda`	the value of the scale parameter, must be positive, the default is 1
`a`	the value of the first shape parameter, must be positive, the default is 1
`b`	the value of the second shape parameter, must be positive, the default is 1
`log`	if TRUE then log(pdf) are returned
`log.p`	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
`lower.tail`	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as `x`, giving the pdf or cdf values computed at `x` or an object of the same length as `p`, giving the values at risk or expected shortfall computed at `p`.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dbetaexp(x)
pbetaexp(x)
varbetaexp(x)
esbetaexp(x)
```

---

betafrechet *Beta Frechet distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the beta Fr\'echet distribution due to Barreto-Souza et al. (2011) given by

$$f(x) = \frac{\alpha \sigma^\alpha}{x^{\alpha+1} B(a,b)} \exp\left\{-a \left(\frac{\sigma}{x}\right)^\alpha\right\} \left[1 - \exp\left\{-\left(\frac{\sigma}{x}\right)^\alpha\right\}\right]^{b-1},$$
$$F(x) = I_{\exp\left\{-\left(\frac{\sigma}{x}\right)^\alpha\right\}}(a,b),$$
$$\mathrm{VaR}_p(X) = \sigma\left[-\log I_p^{-1}(a,b)\right]^{-1/\alpha},$$
$$\mathrm{ES}_p(X) = \frac{\sigma}{p}\int_0^p \left[-\log I_v^{-1}(a,b)\right]^{-1/\alpha} dv$$

for $x > 0$, $0 < p < 1$, $a > 0$, the first shape parameter, $\sigma > 0$, the scale parameter, $b > 0$, the second shape parameter, and $\alpha > 0$, the third shape parameter.

Usage

```
dbetafrechet(x, a=1, b=1, alpha=1, sigma=1, log=FALSE)
pbetafrechet(x, a=1, b=1, alpha=1, sigma=1, log.p=FALSE, lower.tail=TRUE)
varbetafrechet(p, a=1, b=1, alpha=1, sigma=1, log.p=FALSE, lower.tail=TRUE)
esbetafrechet(p, a=1, b=1, alpha=1, sigma=1)
```

Arguments

x	scaler or vector of values at which the pdf or cdf needs to be computed
p	scaler or vector of values at which the value at risk or expected shortfall needs to be computed

`sigma`	the value of the scale parameter, must be positive, the default is 1
`a`	the value of the first shape parameter, must be positive, the default is 1
`b`	the value of the second shape parameter, must be positive, the default is 1
`alpha`	the value of the third shape parameter, must be positive, the default is 1
`log`	if TRUE then log(pdf) are returned
`log.p`	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
`lower.tail`	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as `x`, giving the pdf or cdf values computed at `x` or an object of the same length as `p`, giving the values at risk or expected shortfall computed at `p`.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dbetafrechet(x)
pbetafrechet(x)
varbetafrechet(x)
esbetafrechet(x)
```

`betagompertz` *Beta Gompertz distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the beta Gompertz distribution due to Cordeiro et al. (2012b) given by

$$f(x) = \frac{b\eta \exp(bx)}{B(c,d)} \exp\left(d\eta\right) \exp\left[-d\eta \exp(bx)\right] \left\{1 - \exp\left[\eta - \eta \exp(bx)\right]\right\}^{c-1},$$
$$F(x) = I_{1-\exp[\eta - \eta \exp(bx)]}(c,d),$$
$$\mathrm{VaR}_p(X) = \frac{1}{b} \log\left\{1 - \frac{1}{\eta} \log\left[1 - I_p^{-1}(c,d)\right]\right\},$$
$$\mathrm{ES}_p(X) = \frac{1}{pb} \int_0^p \log\left\{1 - \frac{1}{\eta} \log\left[1 - I_v^{-1}(c,d)\right]\right\} dv$$

for $x > 0$, $0 < p < 1$, $b > 0$, the first scale parameter, $\eta > 0$, the second scale parameter, $c > 0$, the first shape parameter, and $d > 0$, the second shape parameter.

Usage

```
dbetagompertz(x, b=1, c=1, d=1, eta=1, log=FALSE)
pbetagompertz(x, b=1, c=1, d=1, eta=1, log.p=FALSE, lower.tail=TRUE)
varbetagompertz(p, b=1, c=1, d=1, eta=1, log.p=FALSE, lower.tail=TRUE)
esbetagompertz(p, b=1, c=1, d=1, eta=1)
```

Arguments

x	scaler or vector of values at which the pdf or cdf needs to be computed
p	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
b	the value of the first scale parameter, must be positive, the default is 1
eta	the value of the second scale parameter, must be positive, the default is 1
c	the value of the first shape parameter, must be positive, the default is 1
d	the value of the second shape parameter, must be positive, the default is 1
log	if TRUE then log(pdf) are returned
log.p	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
lower.tail	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as x, giving the pdf or cdf values computed at x or an object of the same length as p, giving the values at risk or expected shortfall computed at p.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dbetagompertz(x)
pbetagompertz(x)
varbetagompertz(x)
esbetagompertz(x)
```

betagumbel — *Beta Gumbel distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the beta Gumbel distribution due to Nadarajah and Kotz (2004) given by

$$f(x) = \frac{1}{\sigma B(a,b)} \exp\left(\frac{\mu - x}{\sigma}\right) \exp\left[-a \exp\frac{\mu - x}{\sigma}\right] \left\{1 - \exp\left[-\exp\frac{\mu - x}{\sigma}\right]\right\}^{b-1},$$
$$F(x) = I_{\exp\left[-\exp\frac{\mu - x}{\sigma}\right]}(a,b),$$
$$\mathrm{VaR}_p(X) = \mu - \sigma \log\left[-\log I_p^{-1}(a,b)\right],$$
$$\mathrm{ES}_p(X) = \mu - \frac{\sigma}{p} \int_0^p \log\left[-\log I_v^{-1}(a,b)\right] dv$$

for $-\infty < x < \infty$, $0 < p < 1$, $-\infty < \mu < \infty$, the location parameter, $\sigma > 0$, the scale parameter, $a > 0$, the first shape parameter, and $b > 0$, the second shape parameter.

Usage

```
dbetagumbel(x, a=1, b=1, mu=0, sigma=1, log=FALSE)
pbetagumbel(x, a=1, b=1, mu=0, sigma=1, log.p=FALSE, lower.tail=TRUE)
varbetagumbel(p, a=1, b=1, mu=0, sigma=1, log.p=FALSE, lower.tail=TRUE)
esbetagumbel(p, a=1, b=1, mu=0, sigma=1)
```

Arguments

`x`	scaler or vector of values at which the pdf or cdf needs to be computed
`p`	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
`mu`	the value of the location parameter, can take any real value, the default is zero
`sigma`	the value of the scale parameter, must be positive, the default is 1
`a`	the value of the first shape parameter, must be positive, the default is 1
`b`	the value of the second shape parameter, must be positive, the default is 1
`log`	if TRUE then log(pdf) are returned
`log.p`	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
`lower.tail`	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as `x`, giving the pdf or cdf values computed at `x` or an object of the same length as `p`, giving the values at risk or expected shortfall computed at `p`.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dbetagumbel(x)
pbetagumbel(x)
varbetagumbel(x)
esbetagumbel(x)
```

---

betagumbel2 *Beta Gumbel 2 distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the beta Gumbel II distribution given by

$$f(x) = \frac{abx^{-a-1}}{B(c,d)} \exp\left(-bdx^{-a}\right)\left[1-\exp\left(-bx^{-a}\right)\right]^{c-1},$$
$$F(x) = I_{1-\exp(-bx^{-a})}(c,d),$$
$$\mathrm{VaR}_p(X) = b^{1/a}\left\{-\log\left[1-I_p^{-1}(c,d)\right]\right\}^{-1/a},$$
$$\mathrm{ES}_p(X) = \frac{b^{1/a}}{p}\int_0^p \left\{-\log\left[1-I_v^{-1}(c,d)\right]\right\}^{-1/a} dv$$

for $x > 0$, $0 < p < 1$, $a > 0$, the first shape parameter, $b > 0$, the scale parameter, $c > 0$, the second shape parameter, and $d > 0$, the third shape parameter.

Usage

```
dbetagumbel2(x, a=1, b=1, c=1, d=1, log=FALSE)
pbetagumbel2(x, a=1, b=1, c=1, d=1, log.p=FALSE, lower.tail=TRUE)
varbetagumbel2(p, a=1, b=1, c=1, d=1, log.p=FALSE, lower.tail=TRUE)
esbetagumbel2(p, a=1, b=1, c=1, d=1)
```

Arguments

x	scaler or vector of values at which the pdf or cdf needs to be computed
p	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
b	the value of the scale parameter, must be positive, the default is 1
a	the value of the first shape parameter, must be positive, the default is 1
c	the value of the second shape parameter, must be positive, the default is 1
d	the value of the third shape parameter, must be positive, the default is 1

`log`	if TRUE then log(pdf) are returned
`log.p`	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
`lower.tail`	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as `x`, giving the pdf or cdf values computed at `x` or an object of the same length as `p`, giving the values at risk or expected shortfall computed at `p`.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dbetagumbel2(x)
pbetagumbel2(x)
varbetagumbel2(x)
esbetagumbel2(x, a = 2)
```

---

betalognorm *Beta lognormal distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the beta lognormal distribution due to Castellares et al. (2013) given by

$$f(x) = \frac{1}{\sigma x B(a,b)} \phi \left(\frac{\log x - \mu}{\sigma} \right) \Phi^{a-1} \left(\frac{\log x - \mu}{\sigma} \right) \Phi^{b-1} \left(\frac{\mu - \log x}{\sigma} \right),$$
$$F(x) = I_{\Phi\left(\frac{\log x - \mu}{\sigma}\right)}(a,b),$$
$$\mathrm{VaR}_p(X) = \exp\left[\mu + \sigma \Phi^{-1}\left(I_p^{-1}(a,b)\right)\right],$$
$$\mathrm{ES}_p(X) = \frac{\exp(\mu)}{p} \int_0^p \exp\left[\sigma \Phi^{-1}\left(I_v^{-1}(a,b)\right)\right] dv$$

for $x > 0$, $0 < p < 1$, $-\infty < \mu < \infty$, the location parameter, $\sigma > 0$, the scale parameter, $a > 0$, the first shape parameter, and $b > 0$, the second shape parameter, where $\phi(\cdot)$ denotes the pdf of a standard normal random variable, and $\Phi(\cdot)$ denotes the cdf of a standard normal random variable.

Usage

```
dbetalognorm(x, a=1, b=1, mu=0, sigma=1, log=FALSE)
pbetalognorm(x, a=1, b=1, mu=0, sigma=1, log.p=FALSE, lower.tail=TRUE)
varbetalognorm(p, a=1, b=1, mu=0, sigma=1, log.p=FALSE, lower.tail=TRUE)
esbetalognorm(p, a=1, b=1, mu=0, sigma=1)
```

Arguments

x	scaler or vector of values at which the pdf or cdf needs to be computed
p	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
mu	the value of the location parameter, can take any real value, the default is zero
sigma	the value of the scale parameter, must be positive, the default is 1
a	the value of the first shape parameter, must be positive, the default is 1
b	the value of the second shape parameter, must be positive, the default is 1
log	if TRUE then log(pdf) are returned
log.p	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
lower.tail	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as x, giving the pdf or cdf values computed at x or an object of the same length as p, giving the values at risk or expected shortfall computed at p.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dbetalognorm(x)
pbetalognorm(x)
varbetalognorm(x)
esbetalognorm(x)
```

betalomax *Beta Lomax distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the beta Lomax distribution due to Lemonte and Cordeiro (2013) given by

$$f(x) = \frac{\alpha}{\lambda B(a,b)} \left(1 + \frac{x}{\lambda}\right)^{-b\alpha-1} \left[1 - \left(1 + \frac{x}{\lambda}\right)^{-\alpha}\right]^{a-1},$$
$$F(x) = I_{1-\left(1+\frac{x}{\lambda}\right)^{-\alpha}}(a,b),$$
$$\mathrm{VaR}_p(X) = \lambda \left[1 - I_p^{-1}(a,b)\right]^{-1/\alpha} - \lambda,$$
$$\mathrm{ES}_p(X) = \frac{\lambda}{p} \int_0^p \left[1 - I_v^{-1}(a,b)\right]^{-1/\alpha} dv - \lambda$$

for $x > 0$, $0 < p < 1$, $a > 0$, the first shape parameter, $b > 0$, the second shape parameter, $\alpha > 0$, the third shape parameter, and $\lambda > 0$, the scale parameter.

Usage

```
dbetalomax(x, a=1, b=1, alpha=1, lambda=1, log=FALSE)
pbetalomax(x, a=1, b=1, alpha=1, lambda=1, log.p=FALSE, lower.tail=TRUE)
varbetalomax(p, a=1, b=1, alpha=1, lambda=1, log.p=FALSE, lower.tail=TRUE)
esbetalomax(p, a=1, b=1, alpha=1, lambda=1)
```

Arguments

x	scaler or vector of values at which the pdf or cdf needs to be computed
p	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
lambda	the value of the scale parameter, must be positive, the default is 1
a	the value of the first scale parameter, must be positive, the default is 1
b	the value of the second scale parameter, must be positive, the default is 1
alpha	the value of the third scale parameter, must be positive, the default is 1
log	if TRUE then log(pdf) are returned
log.p	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
lower.tail	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as x, giving the pdf or cdf values computed at x or an object of the same length as p, giving the values at risk or expected shortfall computed at p.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dbetalomax(x)
pbetalomax(x)
varbetalomax(x)
esbetalomax(x)
```

`betanorm` *Beta normal distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the beta normal distribution due to Eugene et al. (2002) given by

$$\begin{aligned}
&f(x) = \frac{1}{\sigma B(a,b)} \phi\left(\frac{x-\mu}{\sigma}\right) \Phi^{a-1}\left(\frac{x-\mu}{\sigma}\right) \Phi^{b-1}\left(\frac{\mu-x}{\sigma}\right), \\
&F(x) = I_{\Phi\left(\frac{x-\mu}{\sigma}\right)}(a,b), \\
&\mathrm{VaR}_p(X) = \mu + \sigma \Phi^{-1}\left(I_p^{-1}(a,b)\right), \\
&\mathrm{ES}_p(X) = \mu + \frac{\sigma}{p} \int_0^p \Phi^{-1}\left(I_v^{-1}(a,b)\right) dv
\end{aligned}$$

for $-\infty < x < \infty$, $0 < p < 1$, $-\infty < \mu < \infty$, the location parameter, $\sigma > 0$, the scale parameter, $a > 0$, the first shape parameter, and $b > 0$, the second shape parameter.

Usage

```
dbetanorm(x, mu=0, sigma=1, a=1, b=1, log=FALSE)
pbetanorm(x, mu=0, sigma=1, a=1, b=1, log.p=FALSE, lower.tail=TRUE)
varbetanorm(p, mu=0, sigma=1, a=1, b=1, log.p=FALSE, lower.tail=TRUE)
esbetanorm(p, mu=0, sigma=1, a=1, b=1)
```

Arguments

`x`	scaler or vector of values at which the pdf or cdf needs to be computed
`p`	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
`mu`	the value of the location parameter, can take any real value, the default is zero
`sigma`	the value of the scale parameter, must be positive, the default is 1
`a`	the value of the first shape parameter, must be positive, the default is 1

b	the value of the second shape parameter, must be positive, the default is 1
log	if TRUE then log(pdf) are returned
log.p	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
lower.tail	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as x, giving the pdf or cdf values computed at x or an object of the same length as p, giving the values at risk or expected shortfall computed at p.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dbetanorm(x)
pbetanorm(x)
varbetanorm(x)
esbetanorm(x)
```

---

betapareto — *Beta Pareto distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the beta Pareto distribution due to Akinsete et al. (2008) given by

$$\begin{array}{l} f(x) = \dfrac{aK^{ad}x^{-ad-1}}{B(c,d)}\left[1-\left(\dfrac{K}{x}\right)^a\right]^{c-1}, \\ F(x) = I_{1-\left(\frac{K}{x}\right)^a}(c,d), \\ \mathrm{VaR}_p(X) = K\left[1-I_p^{-1}(c,d)\right]^{-1/a}, \\ \mathrm{ES}_p(X) = \dfrac{K}{p}\displaystyle\int_0^p \left[1-I_v^{-1}(c,d)\right]^{-1/a} dv \end{array}$$

for $x \geq K$, $0 < p < 1$, $K > 0$, the scale parameter, $a > 0$, the first shape parameter, $c > 0$, the second shape parameter, and $d > 0$, the third shape parameter.

Usage

```
dbetapareto(x, K=1, a=1, c=1, d=1, log=FALSE)
pbetapareto(x, K=1, a=1, c=1, d=1, log.p=FALSE, lower.tail=TRUE)
varbetapareto(p, K=1, a=1, c=1, d=1, log.p=FALSE, lower.tail=TRUE)
esbetapareto(p, K=1, a=1, c=1, d=1)
```

Arguments

x	scaler or vector of values at which the pdf or cdf needs to be computed
p	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
K	the value of the scale parameter, must be positive, the default is 1
a	the value of the first shape parameter, must be positive, the default is 1
c	the value of the second shape parameter, must be positive, the default is 1
d	the value of the third shape parameter, must be positive, the default is 1
log	if TRUE then log(pdf) are returned
log.p	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
lower.tail	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as x, giving the pdf or cdf values computed at x or an object of the same length as p, giving the values at risk or expected shortfall computed at p.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dbetapareto(x)
pbetapareto(x)
varbetapareto(x)
esbetapareto(x)
```

`betaweibull` *Beta Weibull distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the beta Weibull distribution due to Cordeiro et al. (2012b) given by

$$\begin{array}{l} f(x) = \dfrac{\alpha x^{\alpha-1}}{\sigma^\alpha B(a,b)} \exp\left\{-b\left(\dfrac{x}{\sigma}\right)^\alpha\right\} \left[1 - \exp\left\{-\left(\dfrac{x}{\sigma}\right)^\alpha\right\}\right]^{a-1}, \\ F(x) = I_{1-\exp\left\{-\left(\frac{x}{\sigma}\right)^\alpha\right\}}(a,b), \\ \mathrm{VaR}_p(X) = \sigma\left\{-\log\left[1 - I_p^{-1}(a,b)\right]\right\}^{1/\alpha}, \\ \mathrm{ES}_p(X) = \dfrac{\sigma}{p}\displaystyle\int_0^p \left\{-\log\left[1 - I_v^{-1}(a,b)\right]\right\}^{1/\alpha} dv \end{array}$$

for $x > 0$, $0 < p < 1$, $a > 0$, the first shape parameter, $b > 0$, the second shape parameter, $\alpha > 0$, the third shape parameter, and $\sigma > 0$, the scale parameter.

Usage

```
dbetaweibull(x, a=1, b=1, alpha=1, sigma=1, log=FALSE)
pbetaweibull(x, a=1, b=1, alpha=1, sigma=1, log.p=FALSE, lower.tail=TRUE)
varbetaweibull(p, a=1, b=1, alpha=1, sigma=1, log.p=FALSE, lower.tail=TRUE)
esbetaweibull(p, a=1, b=1, alpha=1, sigma=1)
```

Arguments

`x`	scaler or vector of values at which the pdf or cdf needs to be computed
`p`	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
`sigma`	the value of the scale parameter, must be positive, the default is 1
`a`	the value of the first shape parameter, must be positive, the default is 1
`b`	the value of the second shape parameter, must be positive, the default is 1
`alpha`	the value of the third shape parameter, must be positive, the default is 1
`log`	if TRUE then log(pdf) are returned
`log.p`	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
`lower.tail`	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as `x`, giving the pdf or cdf values computed at `x` or an object of the same length as `p`, giving the values at risk or expected shortfall computed at `p`.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dbetaweibull(x)
pbetaweibull(x)
varbetaweibull(x)
esbetaweibull(x)
```

BS *Birnbaum-Saunders distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the Birnbaum-Saunders distribution due to Birnbaum and Saunders (1969a, 1969b) given by

$$
\begin{aligned}
f(x) &= \frac{x^{1/2} + x^{-1/2}}{2\gamma x} \phi \left(\frac{x^{1/2} - x^{-1/2}}{\gamma} \right), \\
F(x) &= \Phi \left(\frac{x^{1/2} - x^{-1/2}}{\gamma} \right), \\
\mathrm{VaR}_p(X) &= \frac{1}{4} \left\{ \gamma \Phi^{-1}(p) + \sqrt{4 + \gamma^2 \left[\Phi^{-1}(p) \right]^2} \right\}^2, \\
\mathrm{ES}_p(X) &= \frac{1}{4p} \int_0^p \left\{ \gamma \Phi^{-1}(v) + \sqrt{4 + \gamma^2 \left[\Phi^{-1}(v) \right]^2} \right\}^2 dv
\end{aligned}
$$

for $x > 0$, $0 < p < 1$, and $\gamma > 0$, the scale parameter.

Usage

```
dBS(x, gamma=1, log=FALSE)
pBS(x, gamma=1, log.p=FALSE, lower.tail=TRUE)
varBS(p, gamma=1, log.p=FALSE, lower.tail=TRUE)
esBS(p, gamma=1)
```

Arguments

`x`	scaler or vector of values at which the pdf or cdf needs to be computed
`p`	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
`gamma`	the value of the scale parameter, must be positive, the default is 1
`log`	if TRUE then log(pdf) are returned
`log.p`	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
`lower.tail`	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as x, giving the pdf or cdf values computed at x or an object of the same length as p, giving the values at risk or expected shortfall computed at p.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dBS(x)
pBS(x)
varBS(x)
esBS(x)
```

---

burr *Burr distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the Burr distribution due to Burr (1942) given by

$$f(x) = \frac{ba^b}{x^{b+1}} \left[1 + (x/a)^{-b}\right]^{-2},$$
$$F(x) = \frac{1}{1 + (x/a)^{-b}},$$
$$\mathrm{VaR}_p(X) = ap^{1/b}(1-p)^{-1/b},$$
$$\mathrm{ES}_p(X) = \frac{a}{p} B_p\left(1/b + 1, 1 - 1/b\right)$$

for $x > 0$, $0 < p < 1$, $a > 0$, the scale parameter, and $b > 0$, the shape parameter, where $B_x(a,b) = \int_0^x t^{a-1}(1-t)^{b-1}dt$ denotes the incomplete beta function.

Usage

```
dburr(x, a=1, b=1, log=FALSE)
pburr(x, a=1, b=1, log.p=FALSE, lower.tail=TRUE)
varburr(p, a=1, b=1, log.p=FALSE, lower.tail=TRUE)
esburr(p, a=1, b=1)
```

Arguments

`x`	scaler or vector of values at which the pdf or cdf needs to be computed
`p`	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
`a`	the value of the scale parameter, must be positive, the default is 1
`b`	the value of the shape parameter, must be positive, the default is 1
`log`	if TRUE then log(pdf) are returned
`log.p`	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
`lower.tail`	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as `x`, giving the pdf or cdf values computed at `x` or an object of the same length as `p`, giving the values at risk or expected shortfall computed at `p`.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dburr(x)
pburr(x)
varburr(x)
esburr(x)
```

`burr7` *Burr XII distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the Burr XII distribution due to Burr (1942) given by

$$\begin{array}{l} f(x) = \dfrac{kcx^{c-1}}{(1+x^c)^{k+1}}, \\ F(x) = 1-(1+x^c)^{-k}, \\ \mathrm{VaR}_p(X) = \left[(1-p)^{-1/k}-1\right]^{1/c}, \\ \mathrm{ES}_p(X) = \dfrac{1}{p}\displaystyle\int_0^p \left[(1-v)^{-1/k}-1\right]^{1/c} dv \end{array}$$

for $x > 0$, $0 < p < 1$, $c > 0$, the first shape parameter, and $k > 0$, the second shape parameter.

Usage

```
dburr7(x, k=1, c=1, log=FALSE)
pburr7(x, k=1, c=1, log.p=FALSE, lower.tail=TRUE)
varburr7(p, k=1, c=1, log.p=FALSE, lower.tail=TRUE)
esburr7(p, k=1, c=1)
```

Arguments

x	scaler or vector of values at which the pdf or cdf needs to be computed
p	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
k	the value of the first shape parameter, must be positive, the default is 1
c	the value of the second shape parameter, must be positive, the default is 1
log	if TRUE then log(pdf) are returned
log.p	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
lower.tail	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as x, giving the pdf or cdf values computed at x or an object of the same length as p, giving the values at risk or expected shortfall computed at p.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dburr7(x)
pburr7(x)
varburr7(x)
esburr7(x)
```

`Cauchy` *Cauchy distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the Cauchy distribution given by

$$f(x) = \frac{1}{\pi} \frac{\sigma}{(x-\mu)^2 + \sigma^2},$$
$$F(x) = \frac{1}{2} + \frac{1}{\pi} \arctan\left(\frac{x-\mu}{\sigma}\right),$$
$$\mathrm{VaR}_p(X) = \mu + \sigma \tan\left(\pi\left(p - \frac{1}{2}\right)\right),$$
$$\mathrm{ES}_p(X) = \mu + \frac{\sigma}{p} \int_0^p \tan\left(\pi\left(v - \frac{1}{2}\right)\right) dv$$

for $-\infty < x < \infty$, $0 < p < 1$, $-\infty < \mu < \infty$, the location parameter, and $\sigma > 0$, the scale parameter.

Usage

```
dCauchy(x, mu=0, sigma=1, log=FALSE)
pCauchy(x, mu=0, sigma=1, log.p=FALSE, lower.tail=TRUE)
varCauchy(p, mu=0, sigma=1, log.p=FALSE, lower.tail=TRUE)
esCauchy(p, mu=0, sigma=1)
```

Arguments

`x`	scaler or vector of values at which the pdf or cdf needs to be computed
`p`	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
`mu`	the value of the location parameter, can take any real value, the default is zero
`sigma`	the value of the scale parameter, must be positive, the default is 1
`log`	if TRUE then log(pdf) are returned
`log.p`	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
`lower.tail`	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as `x`, giving the pdf or cdf values computed at `x` or an object of the same length as `p`, giving the values at risk or expected shortfall computed at `p`.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dCauchy(x)
pCauchy(x)
varCauchy(x)
esCauchy(x)
```

---

chen *Chen distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the Chen distribution due to Chen (2000) given by

$$f(x) = \lambda b x^{b-1} \exp\left(x^b\right) \exp\left[\lambda - \lambda \exp\left(x^b\right)\right],$$
$$F(x) = 1 - \exp\left[\lambda - \lambda \exp\left(x^b\right)\right],$$
$$\mathrm{VaR}_p(X) = \left\{\log\left[1 - \frac{\log(1-p)}{\lambda}\right]\right\}^{1/b},$$
$$\mathrm{ES}_p(X) = \frac{1}{p}\int_0^p \left\{\log\left[1 - \frac{\log(1-v)}{\lambda}\right]\right\}^{1/b} dv$$

for $x > 0$, $0 < p < 1$, $b > 0$, the shape parameter, and $\lambda > 0$, the scale parameter.

Usage

```
dchen(x, b=1, lambda=1, log=FALSE)
pchen(x, b=1, lambda=1, log.p=FALSE, lower.tail=TRUE)
varchen(p, b=1, lambda=1, log.p=FALSE, lower.tail=TRUE)
eschen(p, b=1, lambda=1)
```

Arguments

`x`	scaler or vector of values at which the pdf or cdf needs to be computed
`p`	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
`lambda`	the value of the scale parameter, must be positive, the default is 1
`b`	the value of the shape parameter, must be positive, the default is 1
`log`	if TRUE then log(pdf) are returned
`log.p`	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
`lower.tail`	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as x, giving the pdf or cdf values computed at x or an object of the same length as p, giving the values at risk or expected shortfall computed at p.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dchen(x)
pchen(x)
varchen(x)
eschen(x)
```

---

clg *Compound Laplace gamma distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the compound Laplace gamma distribution given by

$$f(x) = \frac{ab}{2} \left\{ 1 + b \left| x - \theta \right| \right\}^{-(a+1)},$$

$$F(x) = \begin{cases} \frac{1}{2} \left\{ 1 + b \left| x - \theta \right| \right\}^{-a}, & \text{if } x \leq \theta, \\ \\ 1 - \frac{1}{2} \left\{ 1 + b \left| x - \theta \right| \right\}^{-a}, & \text{if } x > \theta, \end{cases}$$

$$\mathrm{VaR}_p(X) = \begin{cases} \theta - \frac{1}{b} - \frac{(2p)^{-1/a}}{b}, & \text{if } p \leq 1/2, \\ \\ \theta - \frac{1}{b} + \frac{(2(1-p))^{-1/a}}{b}, & \text{if } p > 1/2, \end{cases}$$

$$\mathrm{ES}_p(X) = \begin{cases} \theta - \frac{1}{b} - \frac{(2p)^{-1/a}}{b(1-1/a)}, & \text{if } p \leq 1/2, \\ \\ \theta - \frac{1}{b} - \frac{[2(1-p)]^{1-1/a}}{2pb(1-1/a)}, & \text{if } p > 1/2 \end{cases}$$

for $-\infty < x < \infty$, $0 < p < 1$, $-\infty < \theta < \infty$, the location parameter, $b > 0$, the scale parameter, and $a > 0$, the shape parameter.

Usage

```
dclg(x, a=1, b=1, theta=0, log=FALSE)
pclg(x, a=1, b=1, theta=0, log.p=FALSE, lower.tail=TRUE)
varclg(p, a=1, b=1, theta=0, log.p=FALSE, lower.tail=TRUE)
esclg(p, a=1, b=1, theta=0)
```

Arguments

x	scaler or vector of values at which the pdf or cdf needs to be computed
p	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
theta	the value of the location parameter, can take any real value, the default is zero
b	the value of the scale parameter, must be positive, the default is 1
a	the value of the shape parameter, must be positive, the default is 1
log	if TRUE then log(pdf) are returned
log.p	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
lower.tail	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as x, giving the pdf or cdf values computed at x or an object of the same length as p, giving the values at risk or expected shortfall computed at p.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dclg(x)
pclg(x)
varclg(x)
esclg(x)
```

compbeta *Complementary beta distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the complementary beta distribution due to Jones (2002) given by

$$\begin{array}{l} f(x) = B(a,b) \left\{ I_x^{-1}(a,b) \right\}^{1-a} \left\{ 1 - I_x^{-1}(a,b) \right\}^{1-b}, \\ F(x) = I_x^{-1}(a,b), \\ \mathrm{VaR}_p(X) = I_p(a,b), \\ \mathrm{ES}_p(X) = \frac{1}{p} \int_0^p I_v(a,b) dv \end{array}$$

for $0 < x < 1$, $0 < p < 1$, $a > 0$, the first shape parameter, and $b > 0$, the second shape parameter.

Usage

```
dcompbeta(x, a=1, b=1, log=FALSE)
pcompbeta(x, a=1, b=1, log.p=FALSE, lower.tail=TRUE)
varcompbeta(p, a=1, b=1, log.p=FALSE, lower.tail=TRUE)
escompbeta(p, a=1, b=1)
```

Arguments

x	scaler or vector of values at which the pdf or cdf needs to be computed
p	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
a	the value of the first shape parameter, must be positive, the default is 1
b	the value of the second shape parameter, must be positive, the default is 1
log	if TRUE then log(pdf) are returned
log.p	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
lower.tail	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as `x`, giving the pdf or cdf values computed at `x` or an object of the same length as `p`, giving the values at risk or expected shortfall computed at `p`.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dcompbeta(x)
pcompbeta(x)
varcompbeta(x)
escompbeta(x)
```

---

dagum *Dagum distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the Dagum distribution due to Dagum (1975, 1977, 1980) given by

$$f(x) = \frac{acb^a x^{ac-1}}{[x^a + b^a]^{c+1}},$$
$$F(x) = \left[1 + \left(\frac{b}{x}\right)^a\right]^{-c},$$
$$\mathrm{VaR}_p(X) = b\left(1 - p^{-1/c}\right)^{-1/a},$$
$$\mathrm{ES}_p(X) = \frac{b}{p}\int_0^p \left(1 - v^{-1/c}\right)^{-1/a} dv$$

for $x > 0$, $0 < p < 1$, $a > 0$, the first shape parameter, $b > 0$, the scale parameter, and $c > 0$, the second shape parameter.

Usage

```
ddagum(x, a=1, b=1, c=1, log=FALSE)
pdagum(x, a=1, b=1, c=1, log.p=FALSE, lower.tail=TRUE)
vardagum(p, a=1, b=1, c=1, log.p=FALSE, lower.tail=TRUE)
esdagum(p, a=1, b=1, c=1)
```

Arguments

`x`	scaler or vector of values at which the pdf or cdf needs to be computed
`p`	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
`b`	the value of the scale parameter, must be positive, the default is 1
`a`	the value of the first shape parameter, must be positive, the default is 1
`c`	the value of the second shape parameter, must be positive, the default is 1
`log`	if TRUE then log(pdf) are returned
`log.p`	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
`lower.tail`	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as x, giving the pdf or cdf values computed at x or an object of the same length as p, giving the values at risk or expected shortfall computed at p.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
ddagum(x)
pdagum(x)
vardagum(x)
esdagum(x)
```

---

dweibull *Double Weibull distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the double Weibull distribution due to Balakrishnan and Kocherlakota (1985) given by

$$f(x) = \frac{c}{2\sigma} \left| \frac{x-\mu}{\sigma} \right|^{c-1} \exp \left\{ - \left| \frac{x-\mu}{\sigma} \right|^{c} \right\},$$

$$F(x) = \begin{cases} \frac{1}{2} \exp \left\{ - \left(\frac{\mu - x}{\sigma} \right)^{c} \right\}, & \text{if } x \leq \mu, \\ 1 - \frac{1}{2} \exp \left\{ - \left(\frac{x-\mu}{\sigma} \right)^{c} \right\}, & \text{if } x > \mu, \end{cases}$$

$$\mathrm{VaR}_p(X) = \begin{cases} \mu - \sigma \left[-\log(2p) \right]^{1/c}, & \text{if } p \leq 1/2, \\ \mu + \sigma \left[-\log(2(1-p)) \right]^{1/c}, & \text{if } p > 1/2, \end{cases}$$

$$\mathrm{ES}_p(X) = \begin{cases} \mu - \frac{\sigma}{p} \int_0^p \left[-\log 2 - \log v \right]^{1/c} dv, & \text{if } p \leq 1/2, \\ \mu - \frac{\sigma}{p} \int_0^{1/2} \left[-\log 2 - \log v \right]^{1/c} dv \\ \quad + \frac{\sigma}{p} \int_{1/2}^{p} \left[-\log 2 - \log(1-v) \right]^{1/c} dv, & \text{if } p > 1/2 \end{cases}$$

for $-\infty < x < \infty$, $0 < p < 1$, $-\infty < \mu < \infty$, the location parameter, $\sigma > 0$, the scale parameter, and $c > 0$, the shape parameter.

Usage

```
ddweibull(x, c=1, mu=0, sigma=1, log=FALSE)
pdweibull(x, c=1, mu=0, sigma=1, log.p=FALSE, lower.tail=TRUE)
vardweibull(p, c=1, mu=0, sigma=1, log.p=FALSE, lower.tail=TRUE)
esdweibull(p, c=1, mu=0, sigma=1)
```

Arguments

x	scaler or vector of values at which the pdf or cdf needs to be computed
p	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
mu	the value of the location parameter, can take any real value, the default is zero
sigma	the value of the scale parameter, must be positive, the default is 1
c	the value of the shape parameter, must be positive, the default is 1
log	if TRUE then log(pdf) are returned
log.p	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
lower.tail	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as x, giving the pdf or cdf values computed at x or an object of the same length as p, giving the values at risk or expected shortfall computed at p.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
ddweibull(x)
pdweibull(x)
vardweibull(x)
esdweibull(x)
```

expexp *Exponentiated exponential distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the exponentiated exponential distribution due to Gupta and Kundu (1999, 2001) given by

$$f(x) = a\lambda \exp(-\lambda x) \left[1 - \exp(-\lambda x)\right]^{a-1},$$
$$F(x) = \left[1 - \exp(-\lambda x)\right]^{a},$$
$$\mathrm{VaR}_p(X) = -\frac{1}{\lambda} \log\left(1 - p^{1/a}\right),$$
$$\mathrm{ES}_p(X) = -\frac{1}{p\lambda} \int_0^p \log\left(1 - v^{1/a}\right) dv$$

for $x > 0$, $0 < p < 1$, $a > 0$, the shape parameter and $\lambda > 0$, the scale parameter.

Usage

```
dexpexp(x, lambda=1, a=1, log=FALSE)
pexpexp(x, lambda=1, a=1, log.p=FALSE, lower.tail=TRUE)
varexpexp(p, lambda=1, a=1, log.p=FALSE, lower.tail=TRUE)
esexpexp(p, lambda=1, a=1)
```

Arguments

x	scaler or vector of values at which the pdf or cdf needs to be computed
p	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
lambda	the value of the scale parameter, must be positive, the default is 1
a	the value of the shape parameter, must be positive, the default is 1
log	if TRUE then log(pdf) are returned
log.p	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
lower.tail	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as x, giving the pdf or cdf values computed at x or an object of the same length as p, giving the values at risk or expected shortfall computed at p.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dexpexp(x)
pexpexp(x)
varexpexp(x)
esexpexp(x)
```

`expext` *Exponential extension distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the exponential extension distribution due to Nadarajah and Haghighi (2011) given by

$$f(x) = a\lambda(1+\lambda x)^{a-1}\exp\left[1-(1+\lambda x)^a\right],$$
$$F(x) = 1-\exp\left[1-(1+\lambda x)^a\right],$$
$$\mathrm{VaR}_p(X) = \frac{\left[1-\log(1-p)\right]^{1/a}-1}{\lambda},$$
$$\mathrm{ES}_p(X) = -\frac{1}{\lambda}+\frac{1}{\lambda p}\int_0^p \left[1-\log(1-v)\right]^{1/a} dv$$

for $x > 0$, $0 < p < 1$, $a > 0$, the shape parameter and $\lambda > 0$, the scale parameter.

Usage

```
dexpext(x, lambda=1, a=1, log=FALSE)
pexpext(x, lambda=1, a=1, log.p=FALSE, lower.tail=TRUE)
varexpext(p, lambda=1, a=1, log.p=FALSE, lower.tail=TRUE)
esexpext(p, lambda=1, a=1)
```

Arguments

`x`	scaler or vector of values at which the pdf or cdf needs to be computed
`p`	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
`lambda`	the value of the scale parameter, must be positive, the default is 1
`a`	the value of the shape parameter, must be positive, the default is 1
`log`	if TRUE then log(pdf) are returned
`log.p`	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
`lower.tail`	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as x, giving the pdf or cdf values computed at x or an object of the same length as p, giving the values at risk or expected shortfall computed at p.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dexpext(x)
pexpext(x)
varexpext(x)
esexpext(x)
```

---

expgeo *Exponential geometric distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the exponential geometric distribution due to Adamidis and Loukas (1998) given by

$$f(x) = \frac{\lambda\theta\exp(-\lambda x)}{\left[1-(1-\theta)\exp(-\lambda x)\right]^2},$$
$$F(x) = \frac{\theta\exp(-\lambda x)}{1-(1-\theta)\exp(-\lambda x)},$$
$$\mathrm{VaR}_p(X) = -\frac{1}{\lambda}\log\frac{p}{\theta+(1-\theta)p},$$
$$\mathrm{ES}_p(X) = -\frac{\log p}{\lambda} - \frac{\theta\log\theta}{\lambda p(1-\theta)} + \frac{\theta+(1-\theta)p}{\lambda p(1-\theta)}\log\left[\theta+(1-\theta)p\right]$$

for $x > 0$, $0 < p < 1$, $0 < \theta < 1$, the first scale parameter, and $\lambda > 0$, the second scale parameter.

Usage

```
dexpgeo(x, theta=0.5, lambda=1, log=FALSE)
pexpgeo(x, theta=0.5, lambda=1, log.p=FALSE, lower.tail=TRUE)
varexpgeo(p, theta=0.5, lambda=1, log.p=FALSE, lower.tail=TRUE)
esexpgeo(p, theta=0.5, lambda=1)
```

Arguments

`x`	scaler or vector of values at which the pdf or cdf needs to be computed
`p`	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
`theta`	the value of the first scale parameter, must be in the unit interval, the default is 0.5
`lambda`	the value of the second scale parameter, must be positive, the default is 1
`log`	if TRUE then log(pdf) are returned
`log.p`	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
`lower.tail`	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as `x`, giving the pdf or cdf values computed at `x` or an object of the same length as `p`, giving the values at risk or expected shortfall computed at `p`.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dexpgeo(x)
pexpgeo(x)
varexpgeo(x)
esexpgeo(x)
```

---

explog *Exponential logarithmic distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the exponential logarithmic distribution due to Tahmasbi and Rezaei (2008) given by

$$f(x) = -\frac{b(1-a)\exp(-bx)}{\log a\left[1-(1-a)\exp(-bx)\right]},$$
$$F(x) = 1 - \frac{\log\left[1-(1-a)\exp(-bx)\right]}{\log a},$$
$$\mathrm{VaR}_p(X) = -\frac{1}{b}\log\left[\frac{1-a^{1-p}}{1-a}\right],$$
$$\mathrm{ES}_p(X) = -\frac{1}{bp}\int_0^p \log\left[\frac{1-a^{1-v}}{1-a}\right] dv$$

for $x > 0$, $0 < p < 1$, $0 < a < 1$, the first scale parameter, and $b > 0$, the second scale parameter.

Usage

```
dexplog(x, a=0.5, b=1, log=FALSE)
pexplog(x, a=0.5, b=1, log.p=FALSE, lower.tail=TRUE)
varexplog(p, a=0.5, b=1, log.p=FALSE, lower.tail=TRUE)
esexplog(p, a=0.5, b=1)
```

Arguments

x	scaler or vector of values at which the pdf or cdf needs to be computed
p	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
a	the value of the first scale parameter, must be in the unit interval, the default is 0.5
b	the value of the second scale parameter, must be positive, the default is 1
log	if TRUE then log(pdf) are returned
log.p	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
lower.tail	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as x, giving the pdf or cdf values computed at x or an object of the same length as p, giving the values at risk or expected shortfall computed at p.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dexplog(x)
pexplog(x)
varexplog(x)
esexplog(x)
```

---

explogis *Exponentiated logistic distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the exponentiated logistic distribution given by

$$f(x) = (a/b) \exp(-x/b) \left[1 + \exp(-x/b)\right]^{-a-1},$$
$$F(x) = \left[1 + \exp(-x/b)\right]^{-a},$$
$$\mathrm{VaR}_p(X) = -b \log \left[p^{-1/a} - 1\right],$$
$$\mathrm{ES}_p(X) = -\frac{b}{p} \int_0^p \log \left[v^{-1/a} - 1\right] dv$$

for $-\infty < x < \infty$, $0 < p < 1$, $a > 0$, the shape parameter, and $b > 0$, the scale parameter.

Usage

```
dexplogis(x, a=1, b=1, log=FALSE)
pexplogis(x, a=1, b=1, log.p=FALSE, lower.tail=TRUE)
varexplogis(p, a=1, b=1, log.p=FALSE, lower.tail=TRUE)
esexplogis(p, a=1, b=1)
```

Arguments

x	scaler or vector of values at which the pdf or cdf needs to be computed
p	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
b	the value of the scale parameter, must be positive, the default is 1
a	the value of the shape parameter, must be positive, the default is 1
log	if TRUE then log(pdf) are returned
log.p	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
lower.tail	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as x, giving the pdf or cdf values computed at x or an object of the same length as p, giving the values at risk or expected shortfall computed at p.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dexplogis(x)
pexplogis(x)
varexplogis(x)
esexplogis(x)
```

`exponential` *Exponential distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the exponential distribution given by

$$f(x) = \lambda \exp(-\lambda x),$$
$$F(x) = 1 - \exp(-\lambda x),$$
$$\mathrm{VaR}_p(X) = -\frac{1}{\lambda} \log(1-p),$$
$$\mathrm{ES}_p(X) = -\frac{1}{p\lambda} \left\{ \log(1-p)p - p - \log(1-p) \right\}$$

for $x > 0$, $0 < p < 1$, and $\lambda > 0$, the scale parameter.

Usage

```
dexponential(x, lambda=1, log=FALSE)
pexponential(x, lambda=1, log.p=FALSE, lower.tail=TRUE)
varexponential(p, lambda=1, log.p=FALSE, lower.tail=TRUE)
esexponential(p, lambda=1)
```

Arguments

`x`	scaler or vector of values at which the pdf or cdf needs to be computed
`p`	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
`lambda`	the value of the scale parameter, must be positive, the default is 1
`log`	if TRUE then log(pdf) are returned
`log.p`	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
`lower.tail`	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as x, giving the pdf or cdf values computed at x or an object of the same length as p, giving the values at risk or expected shortfall computed at p.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dexponential(x)
pexponential(x)
varexponential(x)
esexponential(x)
```

---

exppois *Exponential Poisson distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the exponential Poisson distribution due to Kus (2007) given by

$$
\begin{aligned}
f(x) &= \frac{b\lambda \exp\left[-bx - \lambda + \lambda \exp(-bx)\right]}{1 - \exp(-\lambda)}, \\
F(x) &= \frac{1 - \exp\left[-\lambda + \lambda \exp(-bx)\right]}{1 - \exp(-\lambda)}, \\
\mathrm{VaR}_p(X) &= -\frac{1}{b} \log\left\{\frac{1}{\lambda} \log\left[1 - p + p\exp(-\lambda)\right] + 1\right\}, \\
\mathrm{ES}_p(X) &= -\frac{1}{bp} \int_0^p \log\left\{\frac{1}{\lambda} \log\left[1 - v + v\exp(-\lambda)\right] + 1\right\} dv
\end{aligned}
$$

for $x > 0$, $0 < p < 1$, $b > 0$, the first scale parameter, and $\lambda > 0$, the second scale parameter.

Usage

```
dexppois(x, b=1, lambda=1, log=FALSE)
pexppois(x, b=1, lambda=1, log.p=FALSE, lower.tail=TRUE)
varexppois(p, b=1, lambda=1, log.p=FALSE, lower.tail=TRUE)
esexppois(p, b=1, lambda=1)
```

Arguments

`x`	scaler or vector of values at which the pdf or cdf needs to be computed
`p`	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
`b`	the value of the first scale parameter, must be positive, the default is 1
`lambda`	the value of the second scale parameter, must be positive, the default is 1
`log`	if TRUE then log(pdf) are returned
`log.p`	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
`lower.tail`	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as `x`, giving the pdf or cdf values computed at `x` or an object of the same length as `p`, giving the values at risk or expected shortfall computed at `p`.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dexppois(x)
pexppois(x)
varexppois(x)
esexppois(x)
```

`exppower` *Exponential power distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the exponential power distribution due to Subbotin (1923) given by

$$
\begin{aligned}
f(x) &= \frac{1}{2a^{1/a}\sigma\Gamma(1+1/a)} \exp\left\{-\frac{\mid x-\mu\mid^a}{a\sigma^a}\right\}, \\
F(x) &= \begin{cases} \frac{1}{2} Q\left(\frac{1}{a}, \frac{(\mu - x)^a}{a\sigma^a}\right), & \text{if } x \leq \mu, \\ 1 - \frac{1}{2} Q\left(\frac{1}{a}, \frac{(x - \mu)^a}{a\sigma^a}\right), & \text{if } x > \mu, \end{cases} \\
\mathrm{VaR}_p(X) &= \begin{cases} \mu - a^{1/a}\sigma \left[Q^{-1}\left(\frac{1}{a}, 2p\right)\right]^{1/a}, & \text{if } p \leq 1/2, \\ \mu + a^{1/a}\sigma \left[Q^{-1}\left(\frac{1}{a}, 2(1-p)\right)\right]^{1/a}, & \text{if } p > 1/2, \end{cases} \\
\mathrm{ES}_p(X) &= \begin{cases} \mu - \frac{a^{1/a}\sigma}{p} \int_0^p \left[Q^{-1}\left(\frac{1}{a}, 2v\right)\right]^{1/a} dv, & \text{if } p \leq 1/2, \\ \mu - \frac{a^{1/a}\sigma}{p} \int_0^{1/2} \left[Q^{-1}\left(\frac{1}{a}, 2v\right)\right]^{1/a} dv \\ \quad + \frac{a^{1/a}\sigma}{p} \int_{1/2}^p \left[Q^{-1}\left(\frac{1}{a}, 2(1-v)\right)\right]^{1/a} dv, & \text{if } p > 1/2 \end{cases}
\end{aligned}
$$

for $-\infty < x < \infty$, $0 < p < 1$, $-\infty < \mu < \infty$, the location parameter, $\sigma > 0$, the scale parameter, and $a > 0$, the shape parameter.

Usage

```
dexppower(x, mu=0, sigma=1, a=1, log=FALSE)
pexppower(x, mu=0, sigma=1, a=1, log.p=FALSE, lower.tail=TRUE)
varexppower(p, mu=0, sigma=1, a=1, log.p=FALSE, lower.tail=TRUE)
esexppower(p, mu=0, sigma=1, a=1)
```

Arguments

`x`	scaler or vector of values at which the pdf or cdf needs to be computed
`p`	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
`mu`	the value of the location parameter, can take any real value, the default is zero
`sigma`	the value of the scale parameter, must be positive, the default is 1
`a`	the value of the shape parameter, must be positive, the default is 1
`log`	if TRUE then log(pdf) are returned
`log.p`	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
`lower.tail`	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as x, giving the pdf or cdf values computed at x or an object of the same length as p, giving the values at risk or expected shortfall computed at p.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dexppower(x)
pexppower(x)
varexppower(x)
esexppower(x)
```

---

expweibull *Exponentiated Weibull distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the exponentiated Weibull distribution due to Mudholkar and Srivastava (1993) and Mudholkar et al. (1995) given by

$$f(x) = a\alpha\sigma^{-\alpha}x^{\alpha-1}\exp\left[-(x/\sigma)^\alpha\right]\left\{1-\exp\left[-(x/\sigma)^\alpha\right]\right\}^{a-1},$$
$$F(x) = \left\{1-\exp\left[-(x/\sigma)^\alpha\right]\right\}^{a},$$
$$\mathrm{VaR}_p(X) = \sigma\left[-\log\left(1-p^{1/a}\right)\right]^{1/\alpha},$$
$$\mathrm{ES}_p(X) = \frac{\sigma}{p}\int_0^p\left[-\log\left(1-v^{1/a}\right)\right]^{1/\alpha}dv$$

for $x > 0$, $0 < p < 1$, $a > 0$, the first shape parameter, $\alpha > 0$, the second shape parameter, and $\sigma > 0$, the scale parameter.

Usage

```
dexpweibull(x, a=1, alpha=1, sigma=1, log=FALSE)
pexpweibull(x, a=1, alpha=1, sigma=1, log.p=FALSE, lower.tail=TRUE)
varexpweibull(p, a=1, alpha=1, sigma=1, log.p=FALSE, lower.tail=TRUE)
esexpweibull(p, a=1, alpha=1, sigma=1)
```

Arguments

x	scaler or vector of values at which the pdf or cdf needs to be computed
p	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
sigma	the value of the scale parameter, must be positive, the default is 1
a	the value of the first shape parameter, must be positive, the default is 1
alpha	the value of the second shape parameter, must be positive, the default is 1
log	if TRUE then log(pdf) are returned
log.p	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
lower.tail	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as x, giving the pdf or cdf values computed at x or an object of the same length as p, giving the values at risk or expected shortfall computed at p.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dexpweibull(x)
pexpweibull(x)
varexpweibull(x)
esexpweibull(x)
```

F *F distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the F distribution given by

$$
\begin{aligned}
f(x) &= \frac{1}{B\left(\frac{d_1}{2}, \frac{d_2}{2}\right)} \left(\frac{d_1}{d_2}\right)^{\frac{d_1}{2}} x^{\frac{d_1}{2}-1} \left(1 + \frac{d_1}{d_2} x\right)^{-\frac{d_1+d_2}{2}}, \\
F(x) &= I_{\frac{d_1 x}{d_1 x + d_2}} \left(\frac{d_1}{2}, \frac{d_2}{2}\right), \\
\mathrm{VaR}_p(X) &= \frac{d_2}{d_1} \frac{I_p^{-1}\left(\frac{d_1}{2}, \frac{d_2}{2}\right)}{1 - I_p^{-1}\left(\frac{d_1}{2}, \frac{d_2}{2}\right)}, \\
\mathrm{ES}_p(X) &= \frac{d_2}{d_1 p} \int_0^p \frac{I_v^{-1}\left(\frac{d_1}{2}, \frac{d_2}{2}\right)}{1 - I_v^{-1}\left(\frac{d_1}{2}, \frac{d_2}{2}\right)} dv
\end{aligned}
$$

for $x \geq K$, $0 < p < 1$, $d_1 > 0$, the first degree of freedom parameter, and $d_2 > 0$, the second degree of freedom parameter.

Usage

```
dF(x, d1=1, d2=1, log=FALSE)
pF(x, d1=1, d2=1, log.p=FALSE, lower.tail=TRUE)
varF(p, d1=1, d2=1, log.p=FALSE, lower.tail=TRUE)
esF(p, d1=1, d2=1)
```

Arguments

`x`	scaler or vector of values at which the pdf or cdf needs to be computed
`p`	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
`d1`	the value of the first degree of freedom parameter, must be positive, the default is 1
`d2`	the value of the second degree of freedom parameter, must be positive, the default is 1
`log`	if TRUE then log(pdf) are returned
`log.p`	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
`lower.tail`	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as `x`, giving the pdf or cdf values computed at `x` or an object of the same length as `p`, giving the values at risk or expected shortfall computed at `p`.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dF(x)
pF(x)
varF(x)
esF(x)
```

FR *Freimer distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the Freimer distribution due to Freimer et al. (1988) given by

$$\mathrm{VaR}_p(X) = \frac{1}{a}\left[\frac{p^b - 1}{b} - \frac{(1-p)^c - 1}{c}\right],$$
$$\mathrm{ES}_p(X) = \frac{1}{a}\left(\frac{1}{c} - \frac{1}{b}\right) + \frac{p^b}{ab(b+1)} + \frac{(1-p)^{c+1} - 1}{pac(c+1)}$$

for $0 < p < 1$, $a > 0$, the scale parameter, $b > 0$, the first shape parameter, and $c > 0$, the second shape parameter.

Usage

```
varFR(p, a=1, b=1, c=1, log.p=FALSE, lower.tail=TRUE)
esFR(p, a=1, b=1, c=1)
```

Arguments

p	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
a	the value of the scale parameter, must be positive, the default is 1
b	the value of the first shape parameter, must be positive, the default is 1
c	the value of the second shape parameter, must be positive, the default is 1
log	if TRUE then log(pdf) are returned
log.p	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
lower.tail	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as x, giving the pdf or cdf values computed at x or an object of the same length as p, giving the values at risk or expected shortfall computed at p.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
varFR(x)
esFR(x)
```

---

frechet *Frechet distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the Fr\'echet distribution due to Fr\'echet (1927) given by

$$\begin{array}{l} f(x) = \dfrac{\alpha \sigma^\alpha}{x^{\alpha+1}} \exp \left\{ - \left(\dfrac{\sigma}{x} \right)^\alpha \right\}, \\ F(x) = \exp \left\{ - \left(\dfrac{\sigma}{x} \right)^\alpha \right\}, \\ \mathrm{VaR}_p(X) = \sigma \left[-\log p \right]^{-1/\alpha}, \\ \mathrm{ES}_p(X) = \dfrac{\sigma}{p} \Gamma \left(1 - 1/\alpha, -\log p \right) \end{array}$$

for $x > 0$, $0 < p < 1$, $\alpha > 0$, the shape parameter, and $\sigma > 0$, the scale parameter, where $\Gamma(a, x) = \int_x^\infty t^{a-1} \exp(-t)\, dt$ denotes the complementary incomplete gamma function.

Usage

```
dfrechet(x, alpha=1, sigma=1, log=FALSE)
pfrechet(x, alpha=1, sigma=1, log.p=FALSE, lower.tail=TRUE)
varfrechet(p, alpha=1, sigma=1, log.p=FALSE, lower.tail=TRUE)
esfrechet(p, alpha=1, sigma=1)
```

Arguments

`x`	scaler or vector of values at which the pdf or cdf needs to be computed
`p`	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
`sigma`	the value of the scale parameter, must be positive, the default is 1
`alpha`	the value of the shape parameter, must be positive, the default is 1
`log`	if TRUE then log(pdf) are returned
`log.p`	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
`lower.tail`	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as `x`, giving the pdf or cdf values computed at `x` or an object of the same length as `p`, giving the values at risk or expected shortfall computed at `p`.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dfrechet(x)
pfrechet(x)
varfrechet(x)
esfrechet(x)
```

`Gamma` *Gamma distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the gamma distribution given by

$$f(x) = \frac{b^a x^{a-1} \exp(-bx)}{\Gamma(a)},$$

$$F(x) = \frac{\gamma(a, bx)}{\Gamma(a)},$$

$$\mathrm{VaR}_p(X) = \frac{1}{b} Q^{-1}(a, 1-p),$$

$$\mathrm{ES}_p(X) = \frac{1}{bp} \int_0^p Q^{-1}(a, 1-v) dv$$

for $x > 0$, $0 < p < 1$, $b > 0$, the scale parameter, and $a > 0$, the shape parameter, where $\gamma(a, x) = \int_0^x t^{a-1} \exp(-t) \, dt$ denotes the incomplete gamma function, $Q(a, x) = \int_x^\infty t^{a-1} \exp(-t) \, dt / \Gamma(a)$ denotes the regularized complementary incomplete gamma function, $\Gamma(a) = \int_0^\infty t^{a-1} \exp(-t) \, dt$ denotes the gamma function, and $Q^{-1}(a, x)$ denotes the inverse of $Q(a, x)$.

Usage

```
dGamma(x, a=1, b=1, log=FALSE)
pGamma(x, a=1, b=1, log.p=FALSE, lower.tail=TRUE)
varGamma(p, a=1, b=1, log.p=FALSE, lower.tail=TRUE)
esGamma(p, a=1, b=1)
```

Arguments

`x`	scaler or vector of values at which the pdf or cdf needs to be computed
`p`	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
`b`	the value of the scale parameter, must be positive, the default is 1
`a`	the value of the shape parameter, must be positive, the default is 1
`log`	if TRUE then log(pdf) are returned
`log.p`	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
`lower.tail`	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as `x`, giving the pdf or cdf values computed at `x` or an object of the same length as `p`, giving the values at risk or expected shortfall computed at `p`.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dGamma(x)
pGamma(x)
varGamma(x)
esGamma(x)
```

`genbeta` *Generalized beta distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the generalized beta distribution given by

$$f(x) = \frac{(x-c)^{a-1}(d-x)^{b-1}}{B(a,b)(d-c)^{a+b-1}},$$
$$F(x) = I_{\frac{x-c}{d-c}}(a,b),$$
$$\mathrm{VaR}_p(X) = c + (d-c)I_p^{-1}(a,b),$$
$$\mathrm{ES}_p(X) = c + \frac{d-c}{p}\int_0^p I_v^{-1}(a,b)dv$$

for $c \le x \le d$, $0 < p < 1$, $a > 0$, the first shape parameter, $b > 0$, the second shape parameter, $-\infty < c < \infty$, the first location parameter, and $-\infty < c < d < \infty$, the second location parameter.

Usage

```
dgenbeta(x, a=1, b=1, c=0, d=1, log=FALSE)
pgenbeta(x, a=1, b=1, c=0, d=1, log.p=FALSE, lower.tail=TRUE)
vargenbeta(p, a=1, b=1, c=0, d=1, log.p=FALSE, lower.tail=TRUE)
esgenbeta(p, a=1, b=1, c=0, d=1)
```

Arguments

`x`	scaler or vector of values at which the pdf or cdf needs to be computed
`p`	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
`c`	the value of the first location parameter, can take any real value, the default is zero
`d`	the value of the second location parameter, can take any real value but must be greater than c, the default is 1
`a`	the value of the first shape parameter, must be positive, the default is 1
`b`	the value of the second shape parameter, must be positive, the default is 1
`log`	if TRUE then log(pdf) are returned
`log.p`	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
`lower.tail`	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as `x`, giving the pdf or cdf values computed at `x` or an object of the same length as `p`, giving the values at risk or expected shortfall computed at `p`.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dgenbeta(x)
pgenbeta(x)
vargenbeta(x)
esgenbeta(x)
```

---

genbeta2 *Generalized beta II distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the generalized beta II distribution given by

$$f(x) = \frac{cx^{ac-1}\left(1-x^c\right)^{b-1}}{B(a,b)},$$
$$F(x) = I_{x^c}(a,b),$$
$$\mathrm{VaR}_p(X) = \left[I_p^{-1}(a,b)\right]^{1/c},$$
$$\mathrm{ES}_p(X) = \frac{1}{p}\int_0^p \left[I_v^{-1}(a,b)\right]^{1/c} dv$$

for $0 < x < 1$, $0 < p < 1$, $a > 0$, the first shape parameter, $b > 0$, the second shape parameter, and $c > 0$, the third shape parameter.

Usage

```
dgenbeta2(x, a=1, b=1, c=1, log=FALSE)
pgenbeta2(x, a=1, b=1, c=1, log.p=FALSE, lower.tail=TRUE)
vargenbeta2(p, a=1, b=1, c=1, log.p=FALSE, lower.tail=TRUE)
esgenbeta2(p, a=1, b=1, c=1)
```

Arguments

x	scaler or vector of values at which the pdf or cdf needs to be computed
p	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
a	the value of the first shape parameter, must be positive, the default is 1

b	the value of the second shape parameter, must be positive, the default is 1
c	the value of the third shape parameter, must be positive, the default is 1
log	if TRUE then log(pdf) are returned
log.p	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
lower.tail	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as x, giving the pdf or cdf values computed at x or an object of the same length as p, giving the values at risk or expected shortfall computed at p.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dgenbeta2(x)
pgenbeta2(x)
vargenbeta2(x)
esgenbeta2(x)
```

---

geninvbeta *Generalized inverse beta distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the generalized inverse beta distribution given by

$$\begin{aligned}
f(x) &= \frac{a x^{ac-1}}{B(c,d)\left(1+x^a\right)^{c+d}}, \\
F(x) &= I_{\frac{x^a}{1+x^a}}(c,d), \\
\mathrm{VaR}_p(X) &= \left[\frac{I_p^{-1}(c,d)}{1-I_p^{-1}(c,d)}\right]^{1/a}, \\
\mathrm{ES}_p(X) &= \frac{1}{p}\int_0^p \left[\frac{I_v^{-1}(c,d)}{1-I_v^{-1}(c,d)}\right]^{1/a} dv
\end{aligned}$$

for $x > 0$, $0 < p < 1$, $a > 0$, the first shape parameter, $c > 0$, the second shape parameter, and $d > 0$, the third shape parameter.

Usage

```
dgeninvbeta(x, a=1, c=1, d=1, log=FALSE)
pgeninvbeta(x, a=1, c=1, d=1, log.p=FALSE, lower.tail=TRUE)
vargeninvbeta(p, a=1, c=1, d=1, log.p=FALSE, lower.tail=TRUE)
esgeninvbeta(p, a=1, c=1, d=1)
```

Arguments

`x`	scaler or vector of values at which the pdf or cdf needs to be computed
`p`	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
`a`	the value of the first shape parameter, must be positive, the default is 1
`c`	the value of the second shape parameter, must be positive, the default is 1
`d`	the value of the second shape parameter, must be positive, the default is 1
`log`	if TRUE then log(pdf) are returned
`log.p`	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
`lower.tail`	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as `x`, giving the pdf or cdf values computed at `x` or an object of the same length as `p`, giving the values at risk or expected shortfall computed at `p`.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dgeninvbeta(x)
pgeninvbeta(x)
vargeninvbeta(x)
esgeninvbeta(x)
```

genlogis *Generalized logistic distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the generalized logistic distribution given by

$$f(x) = \frac{a \exp\left(-\frac{x-\mu}{\sigma}\right)}{\sigma \left\{1 + \exp\left(-\frac{x-\mu}{\sigma}\right)\right\}^{1+a}},$$
$$F(x) = \frac{1}{\left\{1 + \exp\left(-\frac{x-\mu}{\sigma}\right)\right\}^{a}},$$
$$\mathrm{VaR}_p(X) = \mu - \sigma \log\left(p^{-1/a} - 1\right),$$
$$\mathrm{ES}_p(X) = \mu - \frac{\sigma}{p} \int_0^p \log\left(v^{-1/a} - 1\right) dv$$

for $-\infty < x < \infty$, $0 < p < 1$, $-\infty < \mu < \infty$, the location parameter, $\sigma > 0$, the scale parameter, and $a > 0$, the shape parameter.

Usage

```
dgenlogis(x, a=1, mu=0, sigma=1, log=FALSE)
pgenlogis(x, a=1, mu=0, sigma=1, log.p=FALSE, lower.tail=TRUE)
vargenlogis(p, a=1, mu=0, sigma=1, log.p=FALSE, lower.tail=TRUE)
esgenlogis(p, a=1, mu=0, sigma=1)
```

Arguments

x	scaler or vector of values at which the pdf or cdf needs to be computed
p	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
mu	the value of the location parameter, can take any real value, the default is zero
sigma	the value of the scale parameter, must be positive, the default is 1
a	the value of the shape parameter, must be positive, the default is 1
log	if TRUE then log(pdf) are returned
log.p	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
lower.tail	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as x, giving the pdf or cdf values computed at x or an object of the same length as p, giving the values at risk or expected shortfall computed at p.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dgenlogis(x)
pgenlogis(x)
vargenlogis(x)
esgenlogis(x)
```

---

genlogis3 *Generalized logistic III distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the generalized logistic III distribution given by

$$f(x) = \frac{1}{\sigma B(\alpha,\alpha)} \exp\left(\alpha \frac{x-\mu}{\sigma}\right) \left\{1 + \exp\left(\frac{x-\mu}{\sigma}\right)\right\}^{-2\alpha},$$
$$F(x) = I_{\frac{1}{1+\exp\left(-\frac{x-\mu}{\sigma}\right)}}(\alpha,\alpha),$$
$$\mathrm{VaR}_p(X) = \mu - \sigma \log \frac{1 - I_p^{-1}(\alpha,\alpha)}{I_p^{-1}(\alpha,\alpha)},$$
$$\mathrm{ES}_p(X) = \mu - \frac{\sigma}{p} \int_0^p \log \frac{1 - I_v^{-1}(\alpha,\alpha)}{I_v^{-1}(\alpha,\alpha)} dv$$

for $-\infty < x < \infty$, $0 < p < 1$, $-\infty < \mu < \infty$, the location parameter, $\sigma > 0$, the scale parameter, and $\alpha > 0$, the shape parameter.

Usage

```
dgenlogis3(x, alpha=1, mu=0, sigma=1, log=FALSE)
pgenlogis3(x, alpha=1, mu=0, sigma=1, log.p=FALSE, lower.tail=TRUE)
vargenlogis3(p, alpha=1, mu=0, sigma=1, log.p=FALSE, lower.tail=TRUE)
esgenlogis3(p, alpha=1, mu=0, sigma=1)
```

Arguments

x	scaler or vector of values at which the pdf or cdf needs to be computed
p	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
mu	the value of the location parameter, can take any real value, the default is zero
sigma	the value of the scale parameter, must be positive, the default is 1
alpha	the value of the shape parameter, must be positive, the default is 1

log	if TRUE then log(pdf) are returned
log.p	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
lower.tail	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as x, giving the pdf or cdf values computed at x or an object of the same length as p, giving the values at risk or expected shortfall computed at p.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dgenlogis3(x)
pgenlogis3(x)
vargenlogis3(x)
esgenlogis3(x)
```

---

genlogis4 *Generalized logistic IV distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the generalized logistic IV distribution given by

$$f(x) = \frac{1}{\sigma B(\alpha, a)} \exp\left(-\alpha \frac{x-\mu}{\sigma}\right) \left\{1 + \exp\left(-\frac{x-\mu}{\sigma}\right)\right\}^{-\alpha-a},$$
$$F(x) = I_{\frac{1}{1+\exp\left(-\frac{x-\mu}{\sigma}\right)}}(\alpha, a),$$
$$\mathrm{VaR}_p(X) = \mu - \sigma \log \frac{1 - I_p^{-1}(\alpha, a)}{I_p^{-1}(\alpha, a)},$$
$$\mathrm{ES}_p(X) = \mu - \frac{\sigma}{p} \int_0^p \log \frac{1 - I_v^{-1}(\alpha, a)}{I_v^{-1}(\alpha, a)} dv$$

for $-\infty < x < \infty$, $0 < p < 1$, $-\infty < \mu < \infty$, the location parameter, $\sigma > 0$, the scale parameter, $\alpha > 0$, the first shape parameter, and $a > 0$, the second shape parameter.

Usage

```
dgenlogis4(x, a=1, alpha=1, mu=0, sigma=1, log=FALSE)
pgenlogis4(x, a=1, alpha=1, mu=0, sigma=1, log.p=FALSE, lower.tail=TRUE)
vargenlogis4(p, a=1, alpha=1, mu=0, sigma=1, log.p=FALSE, lower.tail=TRUE)
esgenlogis4(p, a=1, alpha=1, mu=0, sigma=1)
```

Arguments

`x`	scaler or vector of values at which the pdf or cdf needs to be computed
`p`	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
`mu`	the value of the location parameter, can take any real value, the default is zero
`sigma`	the value of the scale parameter, must be positive, the default is 1
`alpha`	the value of the first shape parameter, must be positive, the default is 1
`a`	the value of the second shape parameter, must be positive, the default is 1
`log`	if TRUE then log(pdf) are returned
`log.p`	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
`lower.tail`	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as `x`, giving the pdf or cdf values computed at `x` or an object of the same length as `p`, giving the values at risk or expected shortfall computed at `p`.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dgenlogis4(x)
pgenlogis4(x)
vargenlogis4(x)
esgenlogis4(x)
```

genpareto *Generalized Pareto distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the generalized Pareto distribution due to Pickands (1975) given by

$$
\begin{aligned}
f(x) &= \frac{1}{k}\left(1-\frac{cx}{k}\right)^{1/c-1}, \\
F(x) &= 1-\left(1-\frac{cx}{k}\right)^{1/c}, \\
\mathrm{VaR}_p(X) &= \frac{k}{c}\left[1-(1-p)^c\right], \\
\mathrm{ES}_p(X) &= \frac{k}{c}+\frac{k(1-p)^{c+1}}{pc(c+1)}-\frac{k}{pc(c+1)}
\end{aligned}
$$

for $x < k/c$ if $c > 0$, $x > k/c$ if $c < 0$, $x > 0$ if $c = 0$, $0 < p < 1$, $k > 0$, the scale parameter and $-\infty < c < \infty$, the shape parameter.

Usage

```
dgenpareto(x, k=1, c=1, log=FALSE)
pgenpareto(x, k=1, c=1, log.p=FALSE, lower.tail=TRUE)
vargenpareto(p, k=1, c=1, log.p=FALSE, lower.tail=TRUE)
esgenpareto(p, k=1, c=1)
```

Arguments

x	scaler or vector of values at which the pdf or cdf needs to be computed
p	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
k	the value of the scale parameter, must be positive, the default is 1
c	the value of the shape parameter, can take any real value, the default is 1
log	if TRUE then log(pdf) are returned
log.p	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
lower.tail	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as x, giving the pdf or cdf values computed at x or an object of the same length as p, giving the values at risk or expected shortfall computed at p.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dgenpareto(x)
pgenpareto(x)
vargenpareto(x)
esgenpareto(x)
```

`genpowerweibull` *Generalized power Weibull distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the generalized power Weibull distribution due to Nikulin and Haghighi (2006) given by

$$f(x) = a\theta x^{a-1} \left[1 + x^a\right]^{\theta-1} \exp\left\{1 - \left[1 + x^a\right]^\theta\right\},$$
$$F(x) = 1 - \exp\left\{1 - \left[1 + x^a\right]^\theta\right\},$$
$$\mathrm{VaR}_p(X) = \left\{\left[1 - \log(1-p)\right]^{1/\theta} - 1\right\}^{1/a},$$
$$\mathrm{ES}_p(X) = \frac{1}{p}\int_0^p \left\{\left[1 - \log(1-v)\right]^{1/\theta} - 1\right\}^{1/a} dv$$

for $x > 0$, $0 < p < 1$, $a > 0$, the first shape parameter, and $\theta > 0$, the second shape parameter.

Usage

```
dgenpowerweibull(x, a=1, theta=1, log=FALSE)
pgenpowerweibull(x, a=1, theta=1, log.p=FALSE, lower.tail=TRUE)
vargenpowerweibull(p, a=1, theta=1, log.p=FALSE, lower.tail=TRUE)
esgenpowerweibull(p, a=1, theta=1)
```

Arguments

`x`	scaler or vector of values at which the pdf or cdf needs to be computed
`p`	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
`a`	the value of the first shape parameter, must be positive, the default is 1
`theta`	the value of the second shape parameter, must be positive, the default is 1
`log`	if TRUE then log(pdf) are returned
`log.p`	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
`lower.tail`	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as x, giving the pdf or cdf values computed at x or an object of the same length as p, giving the values at risk or expected shortfall computed at p.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dgenpowerweibull(x)
pgenpowerweibull(x)
vargenpowerweibull(x)
esgenpowerweibull(x)
```

---

genunif *Generalized uniform distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the generalized uniform distribution given by

$$\begin{array}{l} f(x) = hkc(x-a)^{c-1}\left[1-k(x-a)^c\right]^{h-1}, \\ F(x) = 1-\left[1-k(x-a)^c\right]^h, \\ \mathrm{VaR}_p(X) = a+k^{-1/c}\left[1-(1-p)^{1/h}\right]^{1/c}, \\ \mathrm{ES}_p(X) = a+\dfrac{k^{-1/c}}{p}\displaystyle\int_0^p\left[1-(1-v)^{1/h}\right]^{1/c}dv \end{array}$$

for $a \leq x \leq a+k^{-1/c}$, $0 < p < 1$, $-\infty < a < \infty$, the location parameter, $c > 0$, the first shape parameter, $k > 0$, the scale parameter, and $h > 0$, the second shape parameter.

Usage

```
dgenunif(x, a=0, c=1, h=1, k=1, log=FALSE)
pgenunif(x, a=0, c=1, h=1, k=1, log.p=FALSE, lower.tail=TRUE)
vargenunif(p, a=0, c=1, h=1, k=1, log.p=FALSE, lower.tail=TRUE)
esgenunif(p, a=0, c=1, h=1, k=1)
```

Arguments

x	scaler or vector of values at which the pdf or cdf needs to be computed
p	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
a	the value of the location parameter, can take any real value, the default is zero
k	the value of the scale parameter, must be positive, the default is 1
c	the value of the first scale parameter, must be positive, the default is 1
h	the value of the second scale parameter, must be positive, the default is 1
log	if TRUE then log(pdf) are returned
log.p	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
lower.tail	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as x, giving the pdf or cdf values computed at x or an object of the same length as p, giving the values at risk or expected shortfall computed at p.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dgenunif(x)
pgenunif(x)
vargenunif(x)
esgenunif(x)
```

---

gev *Generalized extreme value distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the generalized extreme value distribution due to Fisher and Tippett (1928) given by

$$f(x) = \frac{1}{\sigma}\left[1+\xi\left(\frac{x-\mu}{\sigma}\right)\right]^{-1/\xi-1}\exp\left\{-\left[1+\xi\left(\frac{x-\mu}{\sigma}\right)\right]^{-1/\xi}\right\},$$
$$F(x) = \exp\left\{-\left[1+\xi\left(\frac{x-\mu}{\sigma}\right)\right]^{-1/\xi}\right\},$$
$$\mathrm{VaR}_p(X) = \mu-\frac{\sigma}{\xi}+\frac{\sigma}{\xi}(-\log p)^{-\xi},$$
$$\mathrm{ES}_p(X) = \mu-\frac{\sigma}{\xi}+\frac{\sigma}{p\xi}\int_0^p(-\log v)^{-\xi}dv$$

for $x \geq \mu-\sigma/\xi$ if $\xi > 0$, $x \leq \mu-\sigma/\xi$ if $\xi < 0$, $-\infty < x < \infty$ if $\xi = 0$, $0 < p < 1$, $-\infty < \mu < \infty$, the location parameter, $\sigma > 0$, the scale parameter, and $-\infty < \xi < \infty$, the shape parameter.

Usage

```
dgev(x, mu=0, sigma=1, xi=1, log=FALSE)
pgev(x, mu=0, sigma=1, xi=1, log.p=FALSE, lower.tail=TRUE)
vargev(p, mu=0, sigma=1, xi=1, log.p=FALSE, lower.tail=TRUE)
esgev(p, mu=0, sigma=1, xi=1)
```

Arguments

`x`	scaler or vector of values at which the pdf or cdf needs to be computed
`p`	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
`mu`	the value of the location parameter, can take any real value, the default is zero
`sigma`	the value of the scale parameter, must be positive, the default is 1
`xi`	the value of the shape parameter, must be positive, the default is 1
`log`	if TRUE then log(pdf) are returned
`log.p`	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
`lower.tail`	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as `x`, giving the pdf or cdf values computed at `x` or an object of the same length as `p`, giving the values at risk or expected shortfall computed at `p`.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dgev(x)
pgev(x)
vargev(x)
esgev(x)
```

`gompertz` *Gompertz distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the Gompertz distribution due to Gompertz (1825) given by

$$f(x) = b\eta \exp(bx) \exp\left[\eta - \eta \exp(bx)\right],$$
$$F(x) = 1 - \exp\left[\eta - \eta \exp(bx)\right],$$
$$\mathrm{VaR}_p(X) = \frac{1}{b} \log\left[1 - \frac{1}{\eta}\log(1-p)\right],$$
$$\mathrm{ES}_p(X) = \frac{1}{pb} \int_0^p \log\left[1 - \frac{1}{\eta}\log(1-v)\right] dv$$

for $x > 0$, $0 < p < 1$, $b > 0$, the first scale parameter and $\eta > 0$, the second scale parameter.

Usage

```
dgompertz(x, b=1, eta=1, log=FALSE)
pgompertz(x, b=1, eta=1, log.p=FALSE, lower.tail=TRUE)
vargompertz(p, b=1, eta=1, log.p=FALSE, lower.tail=TRUE)
esgompertz(p, b=1, eta=1)
```

Arguments

`x`	scaler or vector of values at which the pdf or cdf needs to be computed
`p`	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
`b`	the value of the first scale parameter, must be positive, the default is 1
`eta`	the value of the second scale parameter, must be positive, the default is 1
`log`	if TRUE then log(pdf) are returned
`log.p`	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
`lower.tail`	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as x, giving the pdf or cdf values computed at x or an object of the same length as p, giving the values at risk or expected shortfall computed at p.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dgompertz(x)
pgompertz(x)
vargompertz(x)
esgompertz(x)
```

---

gumbel — *Gumbel distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the Gumbel distribution given by due to Gumbel (1954) given by

$$
\begin{aligned}
&f(x) = \frac{1}{\sigma} \exp\left(\frac{\mu - x}{\sigma}\right) \exp\left[-\exp\left(\frac{\mu - x}{\sigma}\right)\right], \\
&F(x) = \exp\left[-\exp\left(\frac{\mu - x}{\sigma}\right)\right], \\
&\mathrm{VaR}_p(X) = \mu - \sigma \log(-\log p), \\
&\mathrm{ES}_p(X) = \mu - \frac{\sigma}{p} \int_0^p \log(-\log v) dv
\end{aligned}
$$

for $-\infty < x < \infty$, $0 < p < 1$, $-\infty < \mu < \infty$, the location parameter, and $\sigma > 0$, the scale parameter.

Usage

```
dgumbel(x, mu=0, sigma=1, log=FALSE)
pgumbel(x, mu=0, sigma=1, log.p=FALSE, lower.tail=TRUE)
vargumbel(p, mu=0, sigma=1, log.p=FALSE, lower.tail=TRUE)
esgumbel(p, mu=0, sigma=1)
```

Arguments

`x`	scaler or vector of values at which the pdf or cdf needs to be computed
`p`	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
`mu`	the value of the location parameter, can take any real value, the default is zero
`sigma`	the value of the scale parameter, must be positive, the default is 1
`log`	if TRUE then log(pdf) are returned
`log.p`	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
`lower.tail`	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as `x`, giving the pdf or cdf values computed at `x` or an object of the same length as `p`, giving the values at risk or expected shortfall computed at `p`.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dgumbel(x)
pgumbel(x)
vargumbel(x)
esgumbel(x)
```

`gumbel2` *Gumbel II distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the Gumbel II distribution

$$f(x) = abx^{-a-1} \exp\left(-bx^{-a}\right),$$
$$F(x) = 1 - \exp\left(-bx^{-a}\right),$$
$$\mathrm{VaR}_p(X) = b^{1/a}\left[-\log(1-p)\right]^{-1/a},$$
$$\mathrm{ES}_p(X) = \frac{b^{1/a}}{p}\int_0^p \left[-\log(1-v)\right]^{-1/a} dv$$

for $x > 0$, $0 < p < 1$, $a > 0$, the shape parameter, and $b > 0$, the scale parameter.

Usage

```
dgumbel2(x, a=1, b=1, log=FALSE)
pgumbel2(x, a=1, b=1, log.p=FALSE, lower.tail=TRUE)
vargumbel2(p, a=1, b=1, log.p=FALSE, lower.tail=TRUE)
esgumbel2(p, a=1, b=1)
```

Arguments

`x`	scaler or vector of values at which the pdf or cdf needs to be computed
`p`	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
`a`	the value of the scale parameter, must be positive, the default is 1
`b`	the value of the shape parameter, must be positive, the default is 1
`log`	if TRUE then log(pdf) are returned
`log.p`	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
`lower.tail`	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as `x`, giving the pdf or cdf values computed at `x` or an object of the same length as `p`, giving the values at risk or expected shortfall computed at `p`.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dgumbel2(x)
pgumbel2(x)
vargumbel2(x)
esgumbel2(x)
```

`halfcauchy` *Half Cauchy distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the half Cauchy distribution given by

$$f(x) = \frac{2}{\pi} \frac{\sigma}{x^2 + \sigma^2},$$
$$F(x) = \frac{2}{\pi} \arctan\left(\frac{x}{\sigma}\right),$$
$$\mathrm{VaR}_p(X) = \sigma \tan\left(\frac{\pi p}{2}\right),$$
$$\mathrm{ES}_p(X) = \frac{\sigma}{p} \int_0^p \tan\left(\frac{\pi v}{2}\right) dv$$

for $x > 0$, $0 < p < 1$, and $\sigma > 0$, the scale parameter.

Usage

```
dhalfcauchy(x, sigma=1, log=FALSE)
phalfcauchy(x, sigma=1, log.p=FALSE, lower.tail=TRUE)
varhalfcauchy(p, sigma=1, log.p=FALSE, lower.tail=TRUE)
eshalfcauchy(p, sigma=1)
```

Arguments

`x`	scaler or vector of values at which the pdf or cdf needs to be computed
`p`	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
`sigma`	the value of the scale parameter, must be positive, the default is 1
`log`	if TRUE then log(pdf) are returned
`log.p`	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
`lower.tail`	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as `x`, giving the pdf or cdf values computed at `x` or an object of the same length as `p`, giving the values at risk or expected shortfall computed at `p`.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dhalfcauchy(x)
phalfcauchy(x)
varhalfcauchy(x)
eshalfcauchy(x)
```

---

halflogis — *Half logistic distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the half logistic distribution given by

$$f(x) = \frac{2\lambda \exp(-\lambda x)}{\left[1 + \exp(-\lambda x)\right]^2},$$
$$F(x) = \frac{1 - \exp(-\lambda x)}{1 + \exp(-\lambda x)},$$
$$\mathrm{VaR}_p(X) = -\frac{1}{\lambda} \log \frac{1-p}{1+p},$$
$$\mathrm{ES}_p(X) = -\frac{1}{\lambda} \log \frac{1-p}{1+p} + \frac{1}{\lambda p} \log\left(1 - p^2\right)$$

for $x > 0$, $0 < p < 1$, and $\lambda > 0$, the scale parameter.

Usage

```
dhalflogis(x, lambda=1, log=FALSE)
phalflogis(x, lambda=1, log.p=FALSE, lower.tail=TRUE)
varhalflogis(p, lambda=1, log.p=FALSE, lower.tail=TRUE)
eshalflogis(p, lambda=1)
```

Arguments

`x`	scaler or vector of values at which the pdf or cdf needs to be computed
`p`	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
`lambda`	the value of the scale parameter, must be positive, the default is 1
`log`	if TRUE then log(pdf) are returned
`log.p`	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
`lower.tail`	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as `x`, giving the pdf or cdf values computed at `x` or an object of the same length as `p`, giving the values at risk or expected shortfall computed at `p`.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dhalflogis(x)
phalflogis(x)
varhalflogis(x)
eshalflogis(x)
```

---

halfnorm *Half normal distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for Half normal distribution given by

$$f(x) = \frac{2}{\sigma}\phi\left(\frac{x}{\sigma}\right),$$
$$F(x) = 2\Phi\left(\frac{x}{\sigma}\right) - 1,$$
$$\mathrm{VaR}_p(X) = \sigma\Phi^{-1}\left(\frac{1+p}{2}\right),$$
$$\mathrm{ES}_p(X) = \frac{\sigma}{p}\int_0^p \Phi^{-1}\left(\frac{1+v}{2}\right) dv$$

for $x > 0$, $0 < p < 1$, and $\sigma > 0$, the scale parameter.

Usage

```
dhalfnorm(x, sigma=1, log=FALSE)
phalfnorm(x, sigma=1, log.p=FALSE, lower.tail=TRUE)
varhalfnorm(p, sigma=1, log.p=FALSE, lower.tail=TRUE)
eshalfnorm(p, sigma=1)
```

Arguments

x	scaler or vector of values at which the pdf or cdf needs to be computed
p	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
sigma	the value of the scale parameter, must be positive, the default is 1

`log`	if TRUE then log(pdf) are returned
`log.p`	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
`lower.tail`	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as `x`, giving the pdf or cdf values computed at `x` or an object of the same length as `p`, giving the values at risk or expected shortfall computed at `p`.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dhalfnorm(x)
phalfnorm(x)
varhalfnorm(x)
eshalfnorm(x)
```

`halfT` *Half Student's t distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the half Student's t distribution given by

$$\begin{aligned} f(x) &= \frac{2\Gamma\left(\frac{n+1}{2}\right)}{\sqrt{n\pi}\Gamma\left(\frac{n}{2}\right)}\left(1+\frac{x^2}{n}\right)^{-\frac{n+1}{2}}, \\ F(x) &= I_{\frac{x^2}{x^2+n}}\left(\frac{1}{2},\frac{n}{2}\right), \\ \mathrm{VaR}_p(X) &= \sqrt{\frac{nI_p^{-1}\left(\frac{1}{2},\frac{n}{2}\right)}{1-I_p^{-1}\left(\frac{1}{2},\frac{n}{2}\right)}}, \\ \mathrm{ES}_p(X) &= \frac{\sqrt{n}}{p}\int_0^p\sqrt{\frac{I_v^{-1}\left(\frac{1}{2},\frac{n}{2}\right)}{1-I_v^{-1}\left(\frac{1}{2},\frac{n}{2}\right)}}dv \end{aligned}$$

for $-\infty < x < \infty$, $0 < p < 1$, and $n > 0$, the degree of freedom parameter.

Usage

```
dhalfT(x, n=1, log=FALSE)
phalfT(x, n=1, log.p=FALSE, lower.tail=TRUE)
varhalfT(p, n=1, log.p=FALSE, lower.tail=TRUE)
eshalfT(p, n=1)
```

Arguments

x	scaler or vector of values at which the pdf or cdf needs to be computed
p	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
n	the value of the degree of freedom parameter, must be positive, the default is 1
log	if TRUE then log(pdf) are returned
log.p	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
lower.tail	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as x, giving the pdf or cdf values computed at x or an object of the same length as p, giving the values at risk or expected shortfall computed at p.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dhalfT(x)
phalfT(x)
varhalfT(x)
eshalfT(x)
```

HBlaplace *Holla-Bhattacharya Laplace distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the Holla-Bhattacharya Laplace distribution due to Holla and Bhattacharya (1968) given by

$$f(x) = \begin{cases} a\phi \exp\left\{\phi\left(x-\theta\right)\right\}, & \text{if } x \leq \theta, \\ \\ (1-a)\,\phi \exp\left\{\phi\left(\theta-x\right)\right\}, & \text{if } x > \theta, \end{cases}$$

$$F(x) = \begin{cases} a\exp\left(\phi x-\theta\phi\right), & \text{if } x \leq \theta, \\ \\ 1-(1-a)\exp\left(\theta\phi-\phi x\right), & \text{if } x > \theta, \end{cases}$$

$$\mathrm{VaR}_p(X) = \begin{cases} \theta+\dfrac{1}{\phi}\log\left(\dfrac{p}{a}\right), & \text{if } p \leq a, \\ \\ \theta-\dfrac{1}{\phi}\log\left(\dfrac{1-p}{1-a}\right), & \text{if } p > a, \end{cases}$$

$$\mathrm{ES}_p(X) = \begin{cases} \theta-\dfrac{1}{\phi}+\dfrac{1}{\phi}\log\dfrac{p}{a}, & \text{if } p \leq a, \\ \\ \dfrac{1}{p}\left[\theta(1+p-a)+\dfrac{p-2a-(1-a)\log a}{\phi}+\dfrac{1-p}{\phi}\log\dfrac{1-p}{1-a}\right], & \text{if } p > a \end{cases}$$

for $-\infty < x < \infty$, $0 < p < 1$, $-\infty < \theta < \infty$, the location parameter, $0 < a < 1$, the first scale parameter, and $\phi > 0$, the second scale parameter.

Usage

```
dHBlaplace(x, a=0.5, theta=0, phi=1, log=FALSE)
pHBlaplace(x, a=0.5, theta=0, phi=1, log.p=FALSE, lower.tail=TRUE)
varHBlaplace(p, a=0.5, theta=0, phi=1, log.p=FALSE, lower.tail=TRUE)
esHBlaplace(p, a=0.5, theta=0, phi=1)
```

Arguments

`x`	scaler or vector of values at which the pdf or cdf needs to be computed
`p`	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
`theta`	the value of the location parameter, can take any real value, the default is zero
`a`	the value of the first scale parameter, must be in the unit interval, the default is 0.5
`phi`	the value of the second scale parameter, must be positive, the default is 1
`log`	if TRUE then log(pdf) are returned
`log.p`	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
`lower.tail`	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as x, giving the pdf or cdf values computed at x or an object of the same length as p, giving the values at risk or expected shortfall computed at p.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dHBlaplace(x)
pHBlaplace(x)
varHBlaplace(x)
esHBlaplace(x)
```

HL *Hankin-Lee distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the Hankin-Lee distribution due to Hankin and Lee (2006) given by

$$\begin{aligned}\mathrm{VaR}_p(X) &= \frac{cp^a}{(1-p)^b},\\ \mathrm{ES}_p(X) &= \frac{c}{p} B_p(a+1, 1-b)\end{aligned}$$

for $0 < p < 1$, $c > 0$, the scale parameter, $a > 0$, the first shape parameter, and $b > 0$, the second shape parameter.

Usage

```
varHL(p, a=1, b=1, c=1, log.p=FALSE, lower.tail=TRUE)
esHL(p, a=1, b=1, c=1)
```

Arguments

p	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
c	the value of the scale parameter, must be positive, the default is 1
a	the value of the first shape parameter, must be positive, the default is 1
b	the value of the second shape parameter, must be positive, the default is 1
log	if TRUE then log(pdf) are returned
log.p	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
lower.tail	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as x, giving the pdf or cdf values computed at x or an object of the same length as p, giving the values at risk or expected shortfall computed at p.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
varHL(x)
esHL(x)
```

Hlogis *Hosking logistic distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the Hosking logistic distribution due to Hosking (1989, 1990) given by

$$f(x) = \frac{(1-kx)^{1/k-1}}{\left[1+(1-kx)^{1/k}\right]^2},$$
$$F(x) = \frac{1}{1+(1-kx)^{1/k}},$$
$$\mathrm{VaR}_p(X) = \frac{1}{k}\left[1-\left(\frac{1-p}{p}\right)^k\right],$$
$$\mathrm{ES}_p(X) = \frac{1}{k} - \frac{1}{kp}B_p(1-k,1+k)$$

for $x < 1/k$ if $k > 0$, $x > 1/k$ if $k < 0$, $-\infty < x < \infty$ if $k = 0$, and $-\infty < k < \infty$, the shape parameter.

Usage

```
dHlogis(x, k=1, log=FALSE)
pHlogis(x, k=1, log.p=FALSE, lower.tail=TRUE)
varHlogis(p, k=1, log.p=FALSE, lower.tail=TRUE)
esHlogis(p, k=1)
```

Arguments

`x`	scaler or vector of values at which the pdf or cdf needs to be computed
`p`	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
`k`	the value of the shape parameter, must be positive, the default is 1
`log`	if TRUE then log(pdf) are returned
`log.p`	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
`lower.tail`	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as `x`, giving the pdf or cdf values computed at `x` or an object of the same length as `p`, giving the values at risk or expected shortfall computed at `p`.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dHlogis(x)
pHlogis(x)
varHlogis(x)
esHlogis(x)
```

invbeta *Inverse beta distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the inverse beta distribution given by

$$f(x) = \frac{x^{a-1}}{B(a,b)(1+x)^{a+b}},$$
$$F(x) = I_{\frac{x}{1+x}}(a,b),$$
$$\mathrm{VaR}_p(X) = \frac{I_p^{-1}(a,b)}{1-I_p^{-1}(a,b)},$$
$$\mathrm{ES}_p(X) = \frac{1}{p}\int_0^p \frac{I_v^{-1}(a,b)}{1-I_v^{-1}(a,b)}dv$$

for $x > 0$, $0 < p < 1$, $a > 0$, the first shape parameter, and $b > 0$, the second shape parameter.

Usage

```
dinvbeta(x, a=1, b=1, log=FALSE)
pinvbeta(x, a=1, b=1, log.p=FALSE, lower.tail=TRUE)
varinvbeta(p, a=1, b=1, log.p=FALSE, lower.tail=TRUE)
esinvbeta(p, a=1, b=1)
```

Arguments

x	scaler or vector of values at which the pdf or cdf needs to be computed
p	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
a	the value of the first shape parameter, must be positive, the default is 1
b	the value of the second shape parameter, must be positive, the default is 1
log	if TRUE then log(pdf) are returned
log.p	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
lower.tail	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as x, giving the pdf or cdf values computed at x or an object of the same length as p, giving the values at risk or expected shortfall computed at p.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dinvbeta(x)
pinvbeta(x)
varinvbeta(x)
esinvbeta(x)
```

---

invexpexp *Inverse exponentiated exponential distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the inverse exponentiated exponential distribution due to Ghitany et al. (2013) given by

$$
\begin{aligned}
f(x) &= a\lambda x^{-2} \exp\left(-\frac{\lambda}{x}\right)\left[1-\exp\left(-\frac{\lambda}{x}\right)\right]^{a-1},\\
F(x) &= 1-\left[1-\exp\left(-\frac{\lambda}{x}\right)\right]^{a},\\
\mathrm{VaR}_p(X) &= \lambda\left\{-\log\left[1-(1-p)^{1/a}\right]\right\}^{-1},\\
\mathrm{ES}_p(X) &= \frac{\lambda}{p}\int_0^p \left\{-\log\left[1-(1-v)^{1/a}\right]\right\}^{-1} dv
\end{aligned}
$$

for $x > 0$, $0 < p < 1$, $a > 0$, the shape parameter and $\lambda > 0$, the scale parameter.

Usage

```
dinvexpexp(x, lambda=1, a=1, log=FALSE)
pinvexpexp(x, lambda=1, a=1, log.p=FALSE, lower.tail=TRUE)
varinvexpexp(p, lambda=1, a=1, log.p=FALSE, lower.tail=TRUE)
esinvexpexp(p, lambda=1, a=1)
```

Arguments

x	scaler or vector of values at which the pdf or cdf needs to be computed
p	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
lambda	the value of the scale parameter, must be positive, the default is 1
a	the value of the shape parameter, must be positive, the default is 1
log	if TRUE then log(pdf) are returned
log.p	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
lower.tail	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as x, giving the pdf or cdf values computed at x or an object of the same length as p, giving the values at risk or expected shortfall computed at p.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dinvexpexp(x)
pinvexpexp(x)
varinvexpexp(x)
esinvexpexp(x)
```

---

invgamma *Inverse gamma distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the inverse gamma distribution given by

$$f(x) = \frac{b^a \exp(-b/x)}{x^{a+1}\Gamma(a)},$$
$$F(x) = Q(a, b/x),$$
$$\mathrm{VaR}_p(X) = b\left[Q^{-1}(a,p)\right]^{-1},$$
$$\mathrm{ES}_p(X) = \frac{b}{p}\int_0^p \left[Q^{-1}(a,v)\right]^{-1} dv$$

for $x > 0$, $0 < p < 1$, $a > 0$, the shape parameter, and $b > 0$, the scale parameter.

Usage

```
dinvgamma(x, a=1, b=1, log=FALSE)
pinvgamma(x, a=1, b=1, log.p=FALSE, lower.tail=TRUE)
varinvgamma(p, a=1, b=1, log.p=FALSE, lower.tail=TRUE)
esinvgamma(p, a=1, b=1)
```

Arguments

`x`	scaler or vector of values at which the pdf or cdf needs to be computed
`p`	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
`b`	the value of the scale parameter, must be positive, the default is 1
`a`	the value of the shape parameter, must be positive, the default is 1
`log`	if TRUE then log(pdf) are returned
`log.p`	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
`lower.tail`	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as `x`, giving the pdf or cdf values computed at `x` or an object of the same length as `p`, giving the values at risk or expected shortfall computed at `p`.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dinvgamma(x)
pinvgamma(x)
varinvgamma(x)
esinvgamma(x)
```

`kum` *Kumaraswamy distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the Kumaraswamy distribution due to Kumaraswamy (1980) given by

$$f(x) = abx^{a-1}\left(1-x^a\right)^{b-1},$$
$$F(x) = 1-\left(1-x^a\right)^b,$$
$$\mathrm{VaR}_p(X) = \left[1-(1-p)^{1/b}\right]^{1/a},$$
$$\mathrm{ES}_p(X) = \frac{1}{p}\int_0^p \left[1-(1-v)^{1/b}\right]^{1/a} dv$$

for $0 < x < 1$, $0 < p < 1$, $a > 0$, the first shape parameter, and $b > 0$, the second shape parameter.

Usage

```
dkum(x, a=1, b=1, log=FALSE)
pkum(x, a=1, b=1, log.p=FALSE, lower.tail=TRUE)
varkum(p, a=1, b=1, log.p=FALSE, lower.tail=TRUE)
eskum(p, a=1, b=1)
```

Arguments

x	scaler or vector of values at which the pdf or cdf needs to be computed
p	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
a	the value of the first shape parameter, must be positive, the default is 1
b	the value of the second shape parameter, must be positive, the default is 1
log	if TRUE then log(pdf) are returned
log.p	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
lower.tail	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as x, giving the pdf or cdf values computed at x or an object of the same length as p, giving the values at risk or expected shortfall computed at p.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dkum(x)
pkum(x)
varkum(x)
eskum(x)
```

kumburr7 *Kumaraswamy Burr XII distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the Kumaraswamy Burr XII distribution due to Parana\'iba et al. (2013) given by

$$f(x) = \frac{abkcx^{c-1}}{(1+x^c)^{k+1}} \left[1-(1+x^c)^{-k}\right]^{a-1} \left\{1-\left[1-(1+x^c)^{-k}\right]^a\right\}^{b-1},$$

$$F(x) = 1-\left\{1-\left[1-(1+x^c)^{-k}\right]^a\right\}^b,$$

$$\mathrm{VaR}_p(X) = \left[\left\{1-\left[1-(1-p)^{1/b}\right]^{1/a}\right\}^{-1/k}-1\right]^{1/c},$$

$$\mathrm{ES}_p(X) = \frac{1}{p}\int_0^p \left[\left\{1-\left[1-(1-v)^{1/b}\right]^{1/a}\right\}^{-1/k}-1\right]^{1/c} dv$$

for $x > 0$, $0 < p < 1$, $a > 0$, the first shape parameter, $b > 0$, the second shape parameter, $c > 0$, the third shape parameter, and $k > 0$, the fourth shape parameter.

Usage

```
dkumburr7(x, a=1, b=1, k=1, c=1, log=FALSE)
pkumburr7(x, a=1, b=1, k=1, c=1, log.p=FALSE, lower.tail=TRUE)
varkumburr7(p, a=1, b=1, k=1, c=1, log.p=FALSE, lower.tail=TRUE)
eskumburr7(p, a=1, b=1, k=1, c=1)
```

Arguments

`x`	scaler or vector of values at which the pdf or cdf needs to be computed
`p`	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
`a`	the value of the first shape parameter, must be positive, the default is 1
`b`	the value of the second shape parameter, must be positive, the default is 1
`c`	the value of the third shape parameter, must be positive, the default is 1
`k`	the value of the fourth shape parameter, must be positive, the default is 1
`log`	if TRUE then log(pdf) are returned
`log.p`	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
`lower.tail`	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as `x`, giving the pdf or cdf values computed at `x` or an object of the same length as `p`, giving the values at risk or expected shortfall computed at `p`.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dkumburr7(x)
pkumburr7(x)
varkumburr7(x)
eskumburr7(x)
```

---

kumexp *Kumaraswamy exponential distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the Kumaraswamy exponential distribution due to Cordeiro and de Castro (2011) given by

$$
\begin{aligned}
f(x) &= ab\lambda \exp(-\lambda x) \left[1-\exp(-\lambda x)\right]^{a-1} \left\{1-\left[1-\exp(-\lambda x)\right]^{a}\right\}^{b-1}, \\
F(x) &= 1-\left\{1-\left[1-\exp(-\lambda x)\right]^{a}\right\}^{b}, \\
\mathrm{VaR}_p(X) &= -\frac{1}{\lambda}\log\left\{1-\left[1-(1-p)^{1/b}\right]^{1/a}\right\}, \\
\mathrm{ES}_p(X) &= -\frac{1}{p\lambda}\int_0^p \log\left\{1-\left[1-(1-v)^{1/b}\right]^{1/a}\right\} dv
\end{aligned}
$$

for $x > 0$, $0 < p < 1$, $a > 0$, the first shape parameter, $b > 0$, the second shape parameter, and $\lambda > 0$, the scale parameter.

Usage

```
dkumexp(x, lambda=1, a=1, b=1, log=FALSE)
pkumexp(x, lambda=1, a=1, b=1, log.p=FALSE, lower.tail=TRUE)
varkumexp(p, lambda=1, a=1, b=1, log.p=FALSE, lower.tail=TRUE)
eskumexp(p, lambda=1, a=1, b=1)
```

Arguments

x	scaler or vector of values at which the pdf or cdf needs to be computed
p	scaler or vector of values at which the value at risk or expected shortfall needs to be computed

`lambda`	the value of the scale parameter, must be positive, the default is 1
`a`	the value of the first shape parameter, must be positive, the default is 1
`b`	the value of the second shape parameter, must be positive, the default is 1
`log`	if TRUE then log(pdf) are returned
`log.p`	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
`lower.tail`	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as `x`, giving the pdf or cdf values computed at `x` or an object of the same length as `p`, giving the values at risk or expected shortfall computed at `p`.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dkumexp(x)
pkumexp(x)
varkumexp(x)
eskumexp(x)
```

`kumgamma` *Kumaraswamy gamma distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the Kumaraswamy gamma distribution due to de Pascoa et al. (2011) given by

$$f(x) = cdb^a x^{a-1} \exp(-bx) \frac{\gamma^{c-1}(a,bx)}{\Gamma^c(a)} \left[1 - \frac{\gamma^c(a,bx)}{\Gamma^c(a)}\right]^{d-1},$$

$$F(x) = 1 - \left[1 - \frac{\gamma^c(a,bx)}{\Gamma^c(a)}\right]^d,$$

$$\mathrm{VaR}_p(X) = \frac{1}{b} Q^{-1}\left(a, 1 - \left[1 - (1-p)^{1/d}\right]^{1/c}\right),$$

$$\mathrm{ES}_p(X) = \frac{1}{bp} \int_0^p Q^{-1}\left(a, 1 - \left[1 - (1-v)^{1/d}\right]^{1/c}\right) dv$$

for $x > 0$, $0 < p < 1$, $a > 0$, the first shape parameter, $b > 0$, the scale parameter, $c > 0$, the second shape parameter, and $d > 0$, the third shape parameter.

Usage

```
dkumgamma(x, a=1, b=1, c=1, d=1, log=FALSE)
pkumgamma(x, a=1, b=1, c=1, d=1, log.p=FALSE, lower.tail=TRUE)
varkumgamma(p, a=1, b=1, c=1, d=1, log.p=FALSE, lower.tail=TRUE)
eskumgamma(p, a=1, b=1, c=1, d=1)
```

Arguments

`x`	scaler or vector of values at which the pdf or cdf needs to be computed
`p`	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
`b`	the value of the scale parameter, must be positive, the default is 1
`a`	the value of the first shape parameter, must be positive, the default is 1
`c`	the value of the second shape parameter, must be positive, the default is 1
`d`	the value of the third shape parameter, must be positive, the default is 1
`log`	if TRUE then log(pdf) are returned
`log.p`	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
`lower.tail`	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as `x`, giving the pdf or cdf values computed at `x` or an object of the same length as `p`, giving the values at risk or expected shortfall computed at `p`.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dkumgamma(x)
pkumgamma(x)
varkumgamma(x)
eskumgamma(x)
```

`kumgumbel` *Kumaraswamy Gumbel distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the Kumaraswamy Gumbel distribution due to Cordeiro et al. (2012a) given by

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

$$F(x) = 1 - \left\{1 - \exp\left[-a \exp\left(\frac{\mu - x}{\sigma}\right)\right]\right\}^{b},$$

$$\mathrm{VaR}_p(X) = \mu - \sigma \log\left\{-\log\left[1 - (1-p)^{1/b}\right]^{1/a}\right\},$$

$$\mathrm{ES}_p(X) = \mu - \frac{\sigma}{p} \int_0^p \log\left\{-\log\left[1 - (1-v)^{1/b}\right]^{1/a}\right\} dv$$

for $-\infty < x < \infty$, $0 < p < 1$, $-\infty < \mu < \infty$, the location parameter, $\sigma > 0$, the scale parameter, $a > 0$, the first shape parameter, and $b > 0$, the second shape parameter.

Usage

```
dkumgumbel(x, a=1, b=1, mu=0, sigma=1, log=FALSE)
pkumgumbel(x, a=1, b=1, mu=0, sigma=1, log.p=FALSE, lower.tail=TRUE)
varkumgumbel(p, a=1, b=1, mu=0, sigma=1, log.p=FALSE, lower.tail=TRUE)
eskumgumbel(p, a=1, b=1, mu=0, sigma=1)
```

Arguments

`x`	scaler or vector of values at which the pdf or cdf needs to be computed
`p`	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
`mu`	the value of the location parameter, can take any real value, the default is zero
`sigma`	the value of the scale parameter, must be positive, the default is 1
`a`	the value of the first shape parameter, must be positive, the default is 1
`b`	the value of the second shape parameter, must be positive, the default is 1
`log`	if TRUE then log(pdf) are returned
`log.p`	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
`lower.tail`	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as `x`, giving the pdf or cdf values computed at `x` or an object of the same length as `p`, giving the values at risk or expected shortfall computed at `p`.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dkumgumbel(x)
pkumgumbel(x)
varkumgumbel(x)
eskumgumbel(x)
```

---

kumhalfnorm *Kumaraswamy half normal distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the Kumaraswamy half normal distribution due to Cordeiro et al. (2012c) given by

$$
\begin{aligned}
f(x) &= \frac{2ab}{\sigma}\phi\left(\frac{x}{\sigma}\right)\left[2\Phi\left(\frac{x}{\sigma}\right)-1\right]^{a-1}\left\{1-\left[2\Phi\left(\frac{x}{\sigma}\right)-1\right]^{a}\right\}^{b-1},\\
F(x) &= 1-\left\{1-\left[2\Phi\left(\frac{x}{\sigma}\right)-1\right]^{a}\right\}^{b},\\
\mathrm{VaR}_p(X) &= \sigma\Phi^{-1}\left(\frac{1}{2}+\frac{1}{2}\left[1-(1-p)^{1/b}\right]^{1/a}\right),\\
\mathrm{ES}_p(X) &= \frac{\sigma}{p}\int_0^p \Phi^{-1}\left(\frac{1}{2}+\frac{1}{2}\left[1-(1-v)^{1/b}\right]^{1/a}\right)dv
\end{aligned}
$$

for $x > 0$, $0 < p < 1$, $\sigma > 0$, the scale parameter, $a > 0$, the first shape parameter, and $b > 0$, the second shape parameter.

Usage

```
dkumhalfnorm(x, sigma=1, a=1, b=1, log=FALSE)
pkumhalfnorm(x, sigma=1, a=1, b=1, log.p=FALSE, lower.tail=TRUE)
varkumhalfnorm(p, sigma=1, a=1, b=1, log.p=FALSE, lower.tail=TRUE)
eskumhalfnorm(p, sigma=1, a=1, b=1)
```

Arguments

`x`	scaler or vector of values at which the pdf or cdf needs to be computed
`p`	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
`sigma`	the value of the scale parameter, must be positive, the default is 1
`a`	the value of the first shape parameter, must be positive, the default is 1
`b`	the value of the second shape parameter, must be positive, the default is 1
`log`	if TRUE then log(pdf) are returned
`log.p`	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
`lower.tail`	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as `x`, giving the pdf or cdf values computed at `x` or an object of the same length as `p`, giving the values at risk or expected shortfall computed at `p`.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dkumhalfnorm(x)
pkumhalfnorm(x)
varkumhalfnorm(x)
eskumhalfnorm(x)
```

`kumloglogis` *Kumaraswamy log-logistic distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the Kumaraswamy log-logistic distribution due to de Santana et al. (2012) given by

$$
\begin{aligned}
f(x) &= \frac{ab\beta\alpha^{\beta}x^{a\beta-1}}{\left(\alpha^{\beta}+x^{\beta}\right)^{a+1}}\left[1-\frac{x^{a\beta}}{\left(\alpha^{\beta}+x^{\beta}\right)^{a}}\right]^{b-1}, \\
F(x) &= \left[1-\frac{x^{a\beta}}{\left(\alpha^{\beta}+x^{\beta}\right)^{a}}\right]^{b}, \\
\mathrm{VaR}_p(X) &= \alpha\left\{\left[1-(1-p)^{1/b}\right]^{1/a}-1\right\}^{-1/\beta}, \\
\mathrm{ES}_p(X) &= \frac{\alpha}{p}\int_0^p\left\{\left[1-(1-v)^{1/b}\right]^{1/a}-1\right\}^{-1/\beta}dv
\end{aligned}
$$

for $x > 0$, $0 < p < 1$, $\alpha > 0$, the scale parameter, $\beta > 0$, the first shape parameter, $a > 0$, the second shape parameter, and $b > 0$, the third shape parameter.

Usage

```
dkumloglogis(x, a=1, b=1, alpha=1, beta=1, log=FALSE)
pkumloglogis(x, a=1, b=1, alpha=1, beta=1, log.p=FALSE, lower.tail=TRUE)
varkumloglogis(p, a=1, b=1, alpha=1, beta=1, log.p=FALSE, lower.tail=TRUE)
eskumloglogis(p, a=1, b=1, alpha=1, beta=1)
```

Arguments

`x`	scaler or vector of values at which the pdf or cdf needs to be computed
`p`	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
`alpha`	the value of the scale parameter, must be positive, the default is 1
`beta`	the value of the first shape parameter, must be positive, the default is 1
`a`	the value of the second shape parameter, must be positive, the default is 1
`b`	the value of the third shape parameter, must be positive, the default is 1
`log`	if TRUE then log(pdf) are returned
`log.p`	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
`lower.tail`	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as `x`, giving the pdf or cdf values computed at `x` or an object of the same length as `p`, giving the values at risk or expected shortfall computed at `p`.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dkumloglogis(x)
pkumloglogis(x)
varkumloglogis(x)
eskumloglogis(x)
```

`kumnormal` *Kumaraswamy normal distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for Kumaraswamy normal distribution due to Cordeiro and de Castro (2011) given by

$$\begin{aligned}
f(x) &= \frac{ab}{\sigma}\phi\left(\frac{x-\mu}{\sigma}\right)\Phi^{a-1}\left(\frac{x-\mu}{\sigma}\right)\left[1-\Phi^{a}\left(\frac{x-\mu}{\sigma}\right)\right]^{b-1}, \\
F(x) &= 1-\left[1-\Phi^{a}\left(\frac{x-\mu}{\sigma}\right)\right]^{b}, \\
\mathrm{VaR}_p(X) &= \mu+\sigma\Phi^{-1}\left(\left[1-(1-p)^{1/b}\right]^{1/a}\right), \\
\mathrm{ES}_p(X) &= \mu+\frac{\sigma}{p}\int_0^p \Phi^{-1}\left(\left[1-(1-v)^{1/b}\right]^{1/a}\right)dv
\end{aligned}$$

for $-\infty < x < \infty$, $0 < p < 1$, $-\infty < \mu < \infty$, the location parameter, $\sigma > 0$, the scale parameter, $a > 0$, the first shape parameter, and $b > 0$, the second shape parameter.

Usage

```
dkumnormal(x, mu=0, sigma=1, a=1, b=1, log=FALSE)
pkumnormal(x, mu=0, sigma=1, a=1, b=1, log.p=FALSE, lower.tail=TRUE)
varkumnormal(p, mu=0, sigma=1, a=1, b=1, log.p=FALSE, lower.tail=TRUE)
eskumnormal(p, mu=0, sigma=1, a=1, b=1)
```

Arguments

`x`	scaler or vector of values at which the pdf or cdf needs to be computed
`p`	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
`mu`	the value of the location parameter, can take any real value, the default is zero

`sigma`	the value of the scale parameter, must be positive, the default is 1
`a`	the value of the first shape parameter, must be positive, the default is 1
`b`	the value of the second shape parameter, must be positive, the default is 1
`log`	if TRUE then log(pdf) are returned
`log.p`	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
`lower.tail`	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as `x`, giving the pdf or cdf values computed at `x` or an object of the same length as `p`, giving the values at risk or expected shortfall computed at `p`.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dkumnormal(x)
pkumnormal(x)
varkumnormal(x)
eskumnormal(x)
```

`kumpareto` *Kumaraswamy Pareto distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the Kumaraswamy Pareto distribution due to Pereira et al. (2013) given by

$$f(x) = abcK^c x^{-c-1} \left[1 - \left(\frac{K}{x}\right)^c\right]^{a-1} \left\{1 - \left[1 - \left(\frac{K}{x}\right)^c\right]^a\right\}^{b-1},$$

$$F(x) = 1 - \left\{1 - \left[1 - \left(\frac{K}{x}\right)^c\right]^a\right\}^b,$$

$$\mathrm{VaR}_p(X) = K\left\{1 - \left[1 - (1-p)^{1/b}\right]^{1/a}\right\}^{-1/c},$$

$$\mathrm{ES}_p(X) = \frac{K}{p}\int_0^p \left\{1 - \left[1 - (1-v)^{1/b}\right]^{1/a}\right\}^{-1/c} dv$$

for $x \geq K$, $0 < p < 1$, $K > 0$, the scale parameter, $c > 0$, the first shape parameter, $a > 0$, the second shape parameter, and $b > 0$, the third shape parameter.

Usage

```
dkumpareto(x, K=1, a=1, b=1, c=1, log=FALSE)
pkumpareto(x, K=1, a=1, b=1, c=1, log.p=FALSE, lower.tail=TRUE)
varkumpareto(p, K=1, a=1, b=1, c=1, log.p=FALSE, lower.tail=TRUE)
eskumpareto(p, K=1, a=1, b=1, c=1)
```

Arguments

x	scaler or vector of values at which the pdf or cdf needs to be computed
p	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
K	the value of the scale parameter, must be positive, the default is 1
a	the value of the first shape parameter, must be positive, the default is 1
b	the value of the second shape parameter, must be positive, the default is 1
c	the value of the third shape parameter, must be positive, the default is 1
log	if TRUE then log(pdf) are returned
log.p	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
lower.tail	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as x, giving the pdf or cdf values computed at x or an object of the same length as p, giving the values at risk or expected shortfall computed at p.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dkumpareto(x)
pkumpareto(x)
varkumpareto(x)
eskumpareto(x)
```

`kumweibull` *Kumaraswamy Weibull distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the Kumaraswamy Weibull distribution due to Cordeiro et al. (2010) given by

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

$$F(x) = 1 - \left[1 - \left\{1 - \exp\left[-\left(\frac{x}{\sigma}\right)^\alpha\right]\right\}^a\right]^b,$$

$$\mathrm{VaR}_p(X) = \sigma \left[-\log\left\{1 - \left[1 - (1-p)^{1/b}\right]^{1/a}\right\}\right]^{1/\alpha},$$

$$\mathrm{ES}_p(X) = \frac{\sigma}{p} \int_0^p \left[-\log\left\{1 - \left[1 - (1-v)^{1/b}\right]^{1/a}\right\}\right]^{1/\alpha} dv$$

for $x > 0$, $0 < p < 1$, $a > 0$, the first shape parameter, $b > 0$, the second shape parameter, $\alpha > 0$, the third shape parameter, and $\sigma > 0$, the scale parameter.

Usage

```
dkumweibull(x, a=1, b=1, alpha=1, sigma=1, log=FALSE)
pkumweibull(x, a=1, b=1, alpha=1, sigma=1, log.p=FALSE, lower.tail=TRUE)
varkumweibull(p, a=1, b=1, alpha=1, sigma=1, log.p=FALSE, lower.tail=TRUE)
eskumweibull(p, a=1, b=1, alpha=1, sigma=1)
```

Arguments

`x`	scaler or vector of values at which the pdf or cdf needs to be computed
`p`	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
`sigma`	the value of the scale parameter, must be positive, the default is 1
`a`	the value of the first shape parameter, must be positive, the default is 1
`b`	the value of the second shape parameter, must be positive, the default is 1
`alpha`	the value of the third shape parameter, must be positive, the default is 1
`log`	if TRUE then log(pdf) are returned
`log.p`	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
`lower.tail`	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as `x`, giving the pdf or cdf values computed at `x` or an object of the same length as `p`, giving the values at risk or expected shortfall computed at `p`.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dkumweibull(x)
pkumweibull(x)
varkumweibull(x)
eskumweibull(x)
```

`laplace` *Laplace distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the Laplace distribution due to due to Laplace (1774) given by

$$f(x) = \frac{1}{2\sigma} \exp \left(-\frac{\mid x-\mu \mid}{\sigma} \right),$$

$$F(x) = \begin{cases} \frac{1}{2} \exp \left(\frac{x-\mu}{\sigma} \right), & \text{if } x < \mu, \\ 1 - \frac{1}{2} \exp \left(-\frac{x-\mu}{\sigma} \right), & \text{if } x \geq \mu, \end{cases}$$

$$\mathrm{VaR}_p(X) = \begin{cases} \mu + \sigma \log(2p), & \text{if } p < 1/2, \\ \mu - \sigma \log\left[2(1-p)\right], & \text{if } p \geq 1/2, \end{cases}$$

$$\mathrm{ES}_p(X) = \begin{cases} \mu + \sigma \left[\log(2p) - 1\right], & \text{if } p < 1/2, \\ \mu + \sigma - \frac{\sigma}{p} + \sigma \frac{1-p}{p} \log(1-p) + \sigma \frac{1-p}{p} \log 2, & \text{if } p \geq 1/2 \end{cases}$$

for $-\infty < x < \infty$, $0 < p < 1$, $-\infty < \mu < \infty$, the location parameter, and $\sigma > 0$, the scale parameter.

Usage

```
dlaplace(x, mu=0, sigma=1, log=FALSE)
plaplace(x, mu=0, sigma=1, log.p=FALSE, lower.tail=TRUE)
varlaplace(p, mu=0, sigma=1, log.p=FALSE, lower.tail=TRUE)
eslaplace(p, mu=0, sigma=1)
```

Arguments

`x`	scaler or vector of values at which the pdf or cdf needs to be computed
`p`	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
`mu`	the value of the location parameter, can take any real value, the default is zero
`sigma`	the value of the scale parameter, must be positive, the default is 1
`log`	if TRUE then log(pdf) are returned
`log.p`	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
`lower.tail`	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as `x`, giving the pdf or cdf values computed at `x` or an object of the same length as `p`, giving the values at risk or expected shortfall computed at `p`.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dlaplace(x)
plaplace(x)
varlaplace(x)
eslaplace(x)
```

`lfr` *Linear failure rate distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the linear failure rate distribution due to Bain (1974) given by

$$
\begin{array}{l}
f(x) = (a + bx) \exp\left(-ax - bx^2/2\right), \\
F(x) = 1 - \exp\left(-ax - bx^2/2\right), \\
\mathrm{VaR}_p(X) = \dfrac{-a + \sqrt{a^2 - 2b \log(1-p)}}{b}, \\
\mathrm{ES}_p(X) = -\dfrac{a}{b} + \dfrac{1}{bp} \displaystyle\int_0^p \sqrt{a^2 - 2b \log(1-v)} dv
\end{array}
$$

for $x > 0$, $0 < p < 1$, $a > 0$, the first scale parameter, and $b > 0$, the second scale parameter.

Usage

```
dlfr(x, a=1, b=1, log=FALSE)
plfr(x, a=1, b=1, log.p=FALSE, lower.tail=TRUE)
varlfr(p, a=1, b=1, log.p=FALSE, lower.tail=TRUE)
eslfr(p, a=1, b=1)
```

Arguments

`x`	scaler or vector of values at which the pdf or cdf needs to be computed
`p`	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
`a`	the value of the first scale parameter, must be positive, the default is 1
`b`	the value of the second scale parameter, must be positive, the default is 1
`log`	if TRUE then log(pdf) are returned
`log.p`	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
`lower.tail`	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as `x`, giving the pdf or cdf values computed at `x` or an object of the same length as `p`, giving the values at risk or expected shortfall computed at `p`.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dlfr(x)
plfr(x)
varlfr(x)
eslfr(x)
```

LNbeta	*Libby-Novick beta distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the Libby-Novick beta distribution due to Libby and Novick (1982) given by

$$f(x) = \frac{\lambda^a x^{a-1} (1-x)^{b-1}}{B(a,b) \left[1-(1-\lambda)x\right]^{a+b}},$$
$$F(x) = I_{\frac{\lambda x}{1+(\lambda-1)x}}(a,b),$$
$$\mathrm{VaR}_p(X) = \frac{I_p^{-1}(a,b)}{\lambda-(\lambda-1)I_p^{-1}(a,b)},$$
$$\mathrm{ES}_p(X) = \frac{1}{p}\int_0^p \frac{I_v^{-1}(a,b)}{\lambda-(\lambda-1)I_v^{-1}(a,b)} dv$$

for $0 < x < 1$, $0 < p < 1$, $\lambda > 0$, the scale parameter, $a > 0$, the first shape parameter, and $b > 0$, the second shape parameter.

Usage

```
dLNbeta(x, lambda=1, a=1, b=1, log=FALSE)
pLNbeta(x, lambda=1, a=1, b=1, log.p=FALSE, lower.tail=TRUE)
varLNbeta(p, lambda=1, a=1, b=1, log.p=FALSE, lower.tail=TRUE)
esLNbeta(p, lambda=1, a=1, b=1)
```

Arguments

`x`	scaler or vector of values at which the pdf or cdf needs to be computed
`p`	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
`lambda`	the value of the scale parameter, must be positive, the default is 1
`a`	the value of the first shape parameter, must be positive, the default is 1
`b`	the value of the second shape parameter, must be positive, the default is 1
`log`	if TRUE then log(pdf) are returned
`log.p`	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
`lower.tail`	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as `x`, giving the pdf or cdf values computed at `x` or an object of the same length as `p`, giving the values at risk or expected shortfall computed at `p`.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dLNbeta(x)
pLNbeta(x)
varLNbeta(x)
esLNbeta(x)
```

`logbeta` *Log beta distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the log beta distribution given by

$$f(x) = \frac{(\log d - \log c)^{1-a-b}}{xB(a,b)} (\log x - \log c)^{a-1} (\log d - \log x)^{b-1},$$
$$F(x) = I_{\frac{\log x - \log c}{\log d - \log c}}(a,b),$$
$$\mathrm{VaR}_p(X) = c \left(\frac{d}{c}\right)^{I_p^{-1}(a,b)},$$
$$\mathrm{ES}_p(X) = \frac{c}{p} \int_0^p \left(\frac{d}{c}\right)^{I_v^{-1}(a,b)} dv$$

for $0 < c \leq x \leq d$, $0 < p < 1$, $a > 0$, the first shape parameter, $b > 0$, the second shape parameter, $c > 0$, the first location parameter, and $d > 0$, the second location parameter.

Usage

```
dlogbeta(x, a=1, b=1, c=1, d=2, log=FALSE)
plogbeta(x, a=1, b=1, c=1, d=2, log.p=FALSE, lower.tail=TRUE)
varlogbeta(p, a=1, b=1, c=1, d=2, log.p=FALSE, lower.tail=TRUE)
eslogbeta(p, a=1, b=1, c=1, d=2)
```

Arguments

x	scaler or vector of values at which the pdf or cdf needs to be computed
p	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
c	the value of the first location parameter, must be positive, the default is 1
d	the value of the second location parameter, must be positive and greater than c, the default is 2

a	the value of the first scale parameter, must be positive, the default is 1
b	the value of the second scale parameter, must be positive, the default is 1
log	if TRUE then log(pdf) are returned
log.p	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
lower.tail	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as x, giving the pdf or cdf values computed at x or an object of the same length as p, giving the values at risk or expected shortfall computed at p.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dlogbeta(x)
plogbeta(x)
varlogbeta(x)
eslogbeta(x)
```

---

logcauchy *Log Cauchy distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the log Cauchy distribution given by

$$\begin{array}{l} f(x) = \dfrac{1}{x\pi} \dfrac{\sigma}{(\log x - \mu)^2 + \sigma^2}, \\ F(x) = \dfrac{1}{\pi} \arctan \left(\dfrac{\log x - \mu}{\sigma} \right), \\ \mathrm{VaR}_p(X) = \exp \left[\mu + \sigma \tan \left(\pi p \right) \right], \\ \mathrm{ES}_p(X) = \dfrac{\exp(\mu)}{p} \displaystyle\int_0^p \exp \left[\sigma \tan \left(\pi v \right) \right] dv \end{array}$$

for $x > 0$, $0 < p < 1$, $-\infty < \mu < \infty$, the location parameter, and $\sigma > 0$, the scale parameter.

Usage

```
dlogcauchy(x, mu=0, sigma=1, log=FALSE)
plogcauchy(x, mu=0, sigma=1, log.p=FALSE, lower.tail=TRUE)
varlogcauchy(p, mu=0, sigma=1, log.p=FALSE, lower.tail=TRUE)
eslogcauchy(p, mu=0, sigma=1)
```

Arguments

x	scaler or vector of values at which the pdf or cdf needs to be computed
p	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
mu	the value of the location parameter, can take any real value, the default is zero
sigma	the value of the scale parameter, must be positive, the default is 1
log	if TRUE then log(pdf) are returned
log.p	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
lower.tail	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as x, giving the pdf or cdf values computed at x or an object of the same length as p, giving the values at risk or expected shortfall computed at p.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dlogcauchy(x)
plogcauchy(x)
varlogcauchy(x)

 eslogcauchy(x)
```

`loggamma` *Log gamma distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the log gamma distribution due to Consul and Jain (1971) given by

$$
\begin{aligned}
& f(x) = \frac{a^r x^{a-1} (-\log x)^{r-1}}{\Gamma(r)}, \\
& F(x) = Q(r, -a \log x), \\
& \mathrm{VaR}_p(X) = \exp\left[-\frac{1}{a} Q^{-1}(r, p)\right], \\
& \mathrm{ES}_p(X) = \frac{1}{p} \int_0^p \exp\left[-\frac{1}{a} Q^{-1}(r, v)\right] dv
\end{aligned}
$$

for $x > 0$, $0 < p < 1$, $a > 0$, the first shape parameter, and $r > 0$, the second shape parameter.

Usage

```
dloggamma(x, a=1, r=1, log=FALSE)
ploggamma(x, a=1, r=1, log.p=FALSE, lower.tail=TRUE)
varloggamma(p, a=1, r=1, log.p=FALSE, lower.tail=TRUE)
esloggamma(p, a=1, r=1)
```

Arguments

`x`	scaler or vector of values at which the pdf or cdf needs to be computed
`p`	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
`a`	the value of the first scale parameter, must be positive, the default is 1
`r`	the value of the second scale parameter, must be positive, the default is 1
`log`	if TRUE then log(pdf) are returned
`log.p`	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
`lower.tail`	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as `x`, giving the pdf or cdf values computed at `x` or an object of the same length as `p`, giving the values at risk or expected shortfall computed at `p`.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dloggamma(x)
ploggamma(x)
varloggamma(x)
esloggamma(x)
```

---

logisexp *Logistic exponential distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the logistic exponential distribution due to Lan and Leemis (2008) given by

$$f(x) = \frac{a\lambda \exp(\lambda x) \left[\exp(\lambda x) - 1\right]^{a-1}}{\left\{1 + \left[\exp(\lambda x) - 1\right]^a\right\}^2},$$

$$F(x) = \frac{\left[\exp(\lambda x) - 1\right]^a}{1 + \left[\exp(\lambda x) - 1\right]^a},$$

$$\mathrm{VaR}_p(X) = \frac{1}{\lambda} \log \left[1 + \left(\frac{p}{1-p}\right)^{1/a}\right],$$

$$\mathrm{ES}_p(X) = \frac{1}{p\lambda} \int_0^p \log \left[1 + \left(\frac{v}{1-v}\right)^{1/a}\right] dv$$

for $x > 0$, $0 < p < 1$, $a > 0$, the shape parameter and $\lambda > 0$, the scale parameter.

Usage

```
dlogisexp(x, lambda=1, a=1, log=FALSE)
plogisexp(x, lambda=1, a=1, log.p=FALSE, lower.tail=TRUE)
varlogisexp(p, lambda=1, a=1, log.p=FALSE, lower.tail=TRUE)
eslogisexp(p, lambda=1, a=1)
```

Arguments

x	scaler or vector of values at which the pdf or cdf needs to be computed
p	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
lambda	the value of the scale parameter, must be positive, the default is 1

a	the value of the shape parameter, must be positive, the default is 1
log	if TRUE then log(pdf) are returned
log.p	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
lower.tail	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as x, giving the pdf or cdf values computed at x or an object of the same length as p, giving the values at risk or expected shortfall computed at p.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dlogisexp(x)
plogisexp(x)
varlogisexp(x)
eslogisexp(x)
```

---

logisrayleigh   *Logistic Rayleigh distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the logistic Rayleigh distribution due to Lan and Leemis (2008) given by

$$f(x) = a\lambda x \exp\left(\lambda x^2/2\right) \left[\exp\left(\lambda x^2/2\right) - 1\right]^{a-1} \left\{1 + \left[\exp\left(\lambda x^2/2\right) - 1\right]^a\right\}^{-2},$$
$$F(x) = \frac{\left[\exp\left(\lambda x^2/2\right) - 1\right]^a}{1 + \left[\exp\left(\lambda x^2/2\right) - 1\right]^a},$$
$$\mathrm{VaR}_p(X) = \sqrt{\frac{2}{\lambda}}\sqrt{\log\left[1 + \left(\frac{p}{1-p}\right)^{1/a}\right]},$$
$$\mathrm{ES}_p(X) = \frac{\sqrt{2}}{p\sqrt{\lambda}} \int_0^p \left\{\log\left[1 + \left(\frac{v}{1-v}\right)^{1/a}\right]\right\}^{1/2} dv$$

for $x > 0$, $0 < p < 1$, $a > 0$, the shape parameter, and $\lambda > 0$, the scale parameter.

Usage

```
dlogisrayleigh(x, a=1, lambda=1, log=FALSE)
plogisrayleigh(x, a=1, lambda=1, log.p=FALSE, lower.tail=TRUE)
varlogisrayleigh(p, a=1, lambda=1, log.p=FALSE, lower.tail=TRUE)
eslogisrayleigh(p, a=1, lambda=1)
```

Arguments

`x`	scaler or vector of values at which the pdf or cdf needs to be computed
`p`	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
`lambda`	the value of the scale parameter, must be positive, the default is 1
`a`	the value of the shape parameter, must be positive, the default is 1
`log`	if TRUE then log(pdf) are returned
`log.p`	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
`lower.tail`	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as `x`, giving the pdf or cdf values computed at `x` or an object of the same length as `p`, giving the values at risk or expected shortfall computed at `p`.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dlogisrayleigh(x)
plogisrayleigh(x)
varlogisrayleigh(x)
eslogisrayleigh(x)
```

`logistic` *Logistic distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the logistic distribution given by

$$
\begin{aligned}
f(x) &= \frac{1}{\sigma} \exp\left(-\frac{x-\mu}{\sigma}\right) \left[1 + \exp\left(-\frac{x-\mu}{\sigma}\right)\right]^{-2}, \\
F(x) &= \frac{1}{1 + \exp\left(-\frac{x-\mu}{\sigma}\right)}, \\
\mathrm{VaR}_p(X) &= \mu + \sigma \log\left[p(1-p)\right], \\
\mathrm{ES}_p(X) &= \mu - 2\sigma + \sigma \log p - \sigma \frac{1-p}{p} \log(1-p)
\end{aligned}
$$

for $-\infty < x < \infty$, $0 < p < 1$, $-\infty < \mu < \infty$, the location parameter, and $\sigma > 0$, the scale parameter.

Usage

```
dlogistic(x, mu=0, sigma=1, log=FALSE)
plogistic(x, mu=0, sigma=1, log.p=FALSE, lower.tail=TRUE)
varlogistic(p, mu=0, sigma=1, log.p=FALSE, lower.tail=TRUE)
eslogistic(p, mu=0, sigma=1)
```

Arguments

`x`	scaler or vector of values at which the pdf or cdf needs to be computed
`p`	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
`mu`	the value of the location parameter, can take any real value, the default is zero
`sigma`	the value of the scale parameter, must be positive, the default is 1
`log`	if TRUE then log(pdf) are returned
`log.p`	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
`lower.tail`	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as `x`, giving the pdf or cdf values computed at `x` or an object of the same length as `p`, giving the values at risk or expected shortfall computed at `p`.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dlogistic(x)
plogistic(x)
varlogistic(x)
eslogistic(x)
```

`loglaplace` *Log Laplace distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the log Laplace distribution given by

$$f(x) = \begin{cases} \dfrac{abx^{b-1}}{\delta^b(a+b)}, & \text{if } x \le \delta, \\ \\ \dfrac{ab\delta^a}{x^{a+1}(a+b)}, & \text{if } x > \delta, \end{cases}$$

$$F(x) = \begin{cases} \dfrac{ax^b}{\delta^b(a+b)}, & \text{if } x \le \delta, \\ \\ 1 - \dfrac{b\delta^a}{x^a(a+b)}, & \text{if } x > \delta, \end{cases}$$

$$\mathrm{VaR}_p(X) = \begin{cases} \delta \left[p\dfrac{a+b}{a} \right]^{1/b}, & \text{if } p \le \frac{a}{a+b}, \\ \\ \delta \left[(1-p)\dfrac{a+b}{a} \right]^{-1/a}, & \text{if } p > \frac{a}{a+b}, \end{cases}$$

$$\mathrm{ES}_p(X) = \begin{cases} \dfrac{\delta b}{b+1} \left[p\dfrac{a+b}{a} \right]^{1/b}, & \text{if } p \le \frac{a}{a+b}, \\ \\ \dfrac{a\delta}{p(1+1/b)(a+b)} + \dfrac{a^{1/a}b^{1-1/a}\delta}{p(a+b)(1-1/a)} \\ \quad - \dfrac{\delta(1-p)}{p(1-1/a)} \left[\dfrac{a}{(a+b)(1-p)} \right]^{1/a}, & \text{if } p > \frac{a}{a+b} \end{cases}$$

for $-\infty < x < \infty$, $0 < p < 1$, $\delta > 0$, the scale parameter, $a > 0$, the first shape parameter, and $b > 0$, the second shape parameter.

Usage

```
dloglaplace(x, a=1, b=1, delta=0, log=FALSE)
ploglaplace(x, a=1, b=1, delta=0, log.p=FALSE, lower.tail=TRUE)
varloglaplace(p, a=1, b=1, delta=0, log.p=FALSE, lower.tail=TRUE)
esloglaplace(p, a=1, b=1, delta=0)
```

Arguments

`x`	scaler or vector of values at which the pdf or cdf needs to be computed
`p`	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
`delta`	the value of the scale parameter, must be positive, the default is 1
`a`	the value of the first shape parameter, must be positive, the default is 1
`b`	the value of the second shape parameter, must be positive, the default is 1
`log`	if TRUE then log(pdf) are returned
`log.p`	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
`lower.tail`	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as `x`, giving the pdf or cdf values computed at `x` or an object of the same length as `p`, giving the values at risk or expected shortfall computed at `p`.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dloglaplace(x)
ploglaplace(x)
varloglaplace(x)
esloglaplace(x)
```

`loglog` *Loglog distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the Loglog distribution due to Pham (2002) given by

$$f(x) = a\log(\lambda)x^{a-1}\lambda^{x^a}\exp\left[1-\lambda^{x^a}\right],$$
$$F(x) = 1-\exp\left[1-\lambda^{x^a}\right],$$
$$\mathrm{VaR}_p(X) = \left\{\frac{\log\left[1-\log(1-p)\right]}{\log\lambda}\right\}^{1/a},$$
$$\mathrm{ES}_p(X) = \frac{1}{p(\log\lambda)^{1/a}}\int_0^p \left\{\log\left[1-\log(1-v)\right]\right\}^{1/a} dv$$

for $x > 0$, $0 < p < 1$, $a > 0$, the shape parameter, and $\lambda > 1$, the scale parameter.

Usage

```
dloglog(x, a=1, lambda=2, log=FALSE)
ploglog(x, a=1, lambda=2, log.p=FALSE, lower.tail=TRUE)
varloglog(p, a=1, lambda=2, log.p=FALSE, lower.tail=TRUE)
esloglog(p, a=1, lambda=2)
```

Arguments

`x`	scaler or vector of values at which the pdf or cdf needs to be computed
`p`	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
`lambda`	the value of the scale parameter, must be greater than 1, the default is 2
`a`	the value of the shape parameter, must be positive, the default is 1
`log`	if TRUE then log(pdf) are returned
`log.p`	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
`lower.tail`	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as `x`, giving the pdf or cdf values computed at `x` or an object of the same length as `p`, giving the values at risk or expected shortfall computed at `p`.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dloglog(x)
ploglog(x)
varloglog(x)
esloglog(x)
```

---

loglogis *Log-logistic distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the log-logistic distribution given by

$$f(x) = \frac{ba^b x^{b-1}}{\left(a^b + x^b\right)^2},$$
$$F(x) = \frac{x^b}{a^b + x^b},$$
$$\mathrm{VaR}_p(X) = a\left(\frac{p}{1-p}\right)^{1/b},$$
$$\mathrm{ES}_p(X) = \frac{a}{p} B_p\left(1 + \frac{1}{b}, 1 - \frac{1}{b}\right)$$

for $x > 0$, $0 < p < 1$, $a > 0$, the scale parameter, and $b > 0$, the shape parameter, where $B_x(a,b) = \int_0^x t^{a-1}(1-t)^{b-1}dt$ denotes the incomplete beta function.

Usage

```
dloglogis(x, a=1, b=1, log=FALSE)
ploglogis(x, a=1, b=1, log.p=FALSE, lower.tail=TRUE)
varloglogis(p, a=1, b=1, log.p=FALSE, lower.tail=TRUE)
esloglogis(p, a=1, b=1)
```

Arguments

x	scaler or vector of values at which the pdf or cdf needs to be computed
p	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
a	the value of the scale parameter, must be positive, the default is 1
b	the value of the shape parameter, must be positive, the default is 1
log	if TRUE then log(pdf) are returned
log.p	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
lower.tail	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as x, giving the pdf or cdf values computed at x or an object of the same length as p, giving the values at risk or expected shortfall computed at p.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dloglogis(x)
ploglogis(x)
varloglogis(x)
esloglogis(x)
```

---

lognorm *Lognormal distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the lognormal distribution given by

$$
\begin{aligned}
&f(x) = \frac{1}{\sigma x} \phi \left(\frac{\log x - \mu}{\sigma} \right), \\
&F(x) = \Phi \left(\frac{\log x - \mu}{\sigma} \right), \\
&\mathrm{VaR}_p(X) = \exp \left[\mu + \sigma \Phi^{-1}(p) \right], \\
&\mathrm{ES}_p(X) = \frac{\exp(\mu)}{p} \int_0^p \exp \left[\sigma \Phi^{-1}(v) \right] dv
\end{aligned}
$$

for $x > 0$, $0 < p < 1$, $-\infty < \mu < \infty$, the location parameter, and $\sigma > 0$, the scale parameter.

Usage

```
dlognorm(x, mu=0, sigma=1, log=FALSE)
plognorm(x, mu=0, sigma=1, log.p=FALSE, lower.tail=TRUE)
varlognorm(p, mu=0, sigma=1, log.p=FALSE, lower.tail=TRUE)
eslognorm(p, mu=0, sigma=1)
```

Arguments

`x`	scaler or vector of values at which the pdf or cdf needs to be computed
`p`	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
`mu`	the value of the location parameter, can take any real value, the default is zero
`sigma`	the value of the scale parameter, must be positive, the default is 1
`log`	if TRUE then log(pdf) are returned
`log.p`	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
`lower.tail`	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as `x`, giving the pdf or cdf values computed at `x` or an object of the same length as `p`, giving the values at risk or expected shortfall computed at `p`.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dlognorm(x)
plognorm(x)
varlognorm(x)
eslognorm(x)
```

`lomax` *Lomax distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the Lomax distribution due to Lomax (1954) given by

$$
\begin{aligned}
f(x) &= \frac{a}{\lambda}\left(1+\frac{x}{\lambda}\right)^{-a-1}, \\
F(x) &= 1-\left(1+\frac{x}{\lambda}\right)^{-a}, \\
\mathrm{VaR}_p(X) &= \lambda\left[(1-p)^{-1/a}-1\right], \\
\mathrm{ES}_p(X) &= -\lambda+\frac{\lambda-\lambda(1-p)^{1-1/a}}{p-p/a}
\end{aligned}
$$

for $x > 0$, $0 < p < 1$, $a > 0$, the shape parameter, and $\lambda > 0$, the scale parameter.

Usage

```
dlomax(x, a=1, lambda=1, log=FALSE)
plomax(x, a=1, lambda=1, log.p=FALSE, lower.tail=TRUE)
varlomax(p, a=1, lambda=1, log.p=FALSE, lower.tail=TRUE)
eslomax(p, a=1, lambda=1)
```

Arguments

x	scaler or vector of values at which the pdf or cdf needs to be computed
p	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
lambda	the value of the scale parameter, must be positive, the default is 1
a	the value of the shape parameter, must be positive, the default is 1
log	if TRUE then log(pdf) are returned
log.p	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
lower.tail	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as x, giving the pdf or cdf values computed at x or an object of the same length as p, giving the values at risk or expected shortfall computed at p.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dlomax(x)
plomax(x)
varlomax(x)
eslomax(x)
```

Mlaplace *McGill Laplace distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the McGill Laplace distribution due to McGill (1962) given by

$$f(x) = \begin{cases} \dfrac{1}{2\psi} \exp\left(\dfrac{x-\theta}{\psi}\right), & \text{if } x \le \theta, \\ \\ \dfrac{1}{2\phi} \exp\left(\dfrac{\theta-x}{\phi}\right), & \text{if } x > \theta, \end{cases}$$

$$F(x) = \begin{cases} \dfrac{1}{2} \exp\left(\dfrac{x-\theta}{\psi}\right), & \text{if } x \le \theta, \\ \\ 1 - \dfrac{1}{2} \exp\left(\dfrac{\theta-x}{\phi}\right), & \text{if } x > \theta, \end{cases}$$

$$\mathrm{VaR}_p(X) = \begin{cases} \theta + \psi \log(2p), & \text{if } p \le 1/2, \\ \\ \theta - \phi \log\left(2(1-p)\right), & \text{if } p > 1/2, \end{cases}$$

$$\mathrm{ES}_p(X) = \begin{cases} \psi + \theta \log(2p) - \theta p, & \text{if } p \le 1/2, \\ \\ \theta + \phi + \dfrac{\psi - \phi - 2\theta}{2p} + \dfrac{\phi}{p} \log 2 - \phi \log 2 \\ \quad + \dfrac{\phi}{p} \log(1-p) - \phi \log(1-p), & \text{if } p > 1/2 \end{cases}$$

for $-\infty < x < \infty$, $0 < p < 1$, $-\infty < \theta < \infty$, the location parameter, $\phi > 0$, the first scale parameter, and $\psi > 0$, the second scale parameter.

Usage

```
dMlaplace(x, theta=0, phi=1, psi=1, log=FALSE)
pMlaplace(x, theta=0, phi=1, psi=1, log.p=FALSE, lower.tail=TRUE)
varMlaplace(p, theta=0, phi=1, psi=1, log.p=FALSE, lower.tail=TRUE)
esMlaplace(p, theta=0, phi=1, psi=1)
```

Arguments

x	scaler or vector of values at which the pdf or cdf needs to be computed
p	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
theta	the value of the location parameter, can take any real value, the default is zero
phi	the value of the first scale parameter, must be positive, the default is 1
psi	the value of the second scale parameter, must be positive, the default is 1

`log`	if TRUE then log(pdf) are returned
`log.p`	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
`lower.tail`	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as `x`, giving the pdf or cdf values computed at `x` or an object of the same length as `p`, giving the values at risk or expected shortfall computed at `p`.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dMlaplace(x)
pMlaplace(x)
varMlaplace(x)
esMlaplace(x)
```

`moexp` *Marshall-Olkin exponential distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the Marshall-Olkin exponential distribution due to Marshall and Olkin (1997) given by

$$f(x) = \frac{\lambda \exp(\lambda x)}{[\exp(\lambda x) - 1 + a]^2},$$
$$F(x) = \frac{\exp(\lambda x) - 2 + a}{\exp(\lambda x) - 1 + a},$$
$$\mathrm{VaR}_p(X) = \frac{1}{\lambda} \log \frac{2 - a - (1-a)p}{1-p},$$
$$\mathrm{ES}_p(X) = \frac{1}{\lambda} \log\left[2 - a - (1-a)p\right] - \frac{2-a}{\lambda(1-a)p} \log \frac{2 - a - (1-a)p}{2-a} + \frac{1-p}{\lambda p} \log(1-p)$$

for $x > 0$, $0 < p < 1$, $a > 0$, the first scale parameter and $\lambda > 0$, the second scale parameter.

Usage

```
dmoexp(x, lambda=1, a=1, log=FALSE)
pmoexp(x, lambda=1, a=1, log.p=FALSE, lower.tail=TRUE)
varmoexp(p, lambda=1, a=1, log.p=FALSE, lower.tail=TRUE)
esmoexp(p, lambda=1, a=1)
```

Arguments

x	scaler or vector of values at which the pdf or cdf needs to be computed
p	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
a	the value of the first scale parameter, must be positive, the default is 1
lambda	the value of the second scale parameter, must be positive, the default is 1
log	if TRUE then log(pdf) are returned
log.p	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
lower.tail	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as x, giving the pdf or cdf values computed at x or an object of the same length as p, giving the values at risk or expected shortfall computed at p.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dmoexp(x)
pmoexp(x)
varmoexp(x)
esmoexp(x)
```

moweibull *Marshall-Olkin Weibull distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the Marshall-Olkin Weibull distribution due to Marshall and Olkin (1997) given by

$$f(x) = b\lambda^b x^{b-1} \exp\left[(\lambda x)^b\right] \left\{\exp\left[(\lambda x)^b\right] - 1 + a\right\}^{-2},$$
$$F(x) = \frac{\exp\left[(\lambda x)^b\right] - 2 + a}{\exp\left[(\lambda x)^b\right] - 1 + a},$$
$$\mathrm{VaR}_p(X) = \frac{1}{\lambda}\left[\log\left(\frac{1}{1-p} + 1 - a\right)\right]^{1/b},$$
$$\mathrm{ES}_p(X) = \frac{1}{\lambda p}\int_0^p \left[\log\left(\frac{1}{1-v} + 1 - a\right)\right]^{1/b} dv$$

for $x > 0$, $0 < p < 1$, $a > 0$, the first scale parameter, $b > 0$, the shape parameter, and $\lambda > 0$, the second scale parameter.

Usage

```
dmoweibull(x, a=1, b=1, lambda=1, log=FALSE)
pmoweibull(x, a=1, b=1, lambda=1, log.p=FALSE, lower.tail=TRUE)
varmoweibull(p, a=1, b=1, lambda=1, log.p=FALSE, lower.tail=TRUE)
esmoweibull(p, a=1, b=1, lambda=1)
```

Arguments

x	scaler or vector of values at which the pdf or cdf needs to be computed
p	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
a	the value of the first scale parameter, must be positive, the default is 1
lambda	the value of the second scale parameter, must be positive, the default is 1
b	the value of the shape parameter, must be positive, the default is 1
log	if TRUE then log(pdf) are returned
log.p	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
lower.tail	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as x, giving the pdf or cdf values computed at x or an object of the same length as p, giving the values at risk or expected shortfall computed at p.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dmoweibull(x)
pmoweibull(x)
varmoweibull(x)
esmoweibull(x)
```

MRbeta *McDonald-Richards beta distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the McDonald-Richards beta distribution due to McDonald and Richards (1987a, 1987b) given by

$$
\begin{aligned}
f(x) &= \frac{x^{ar-1}\left(bq^r - x^r\right)^{b-1}}{\left(bq^r\right)^{a+b-1} B(a,b)},\\
F(x) &= I_{\frac{x^r}{bq^r}}(a,b),\\
\mathrm{VaR}_p(X) &= b^{1/r} q \left[I_p^{-1}(a,b)\right]^{1/r},\\
\mathrm{ES}_p(X) &= \frac{b^{1/r} q}{p} \int_0^p \left[I_v^{-1}(a,b)\right]^{1/r} dv
\end{aligned}
$$

for $0 \leq x \leq b^{1/r} q$, $0 < p < 1$, $q > 0$, the scale parameter, $a > 0$, the first shape parameter, $b > 0$, the second shape parameter, and $r > 0$, the third shape parameter.

Usage

```
dMRbeta(x, a=1, b=1, r=1, q=1, log=FALSE)
pMRbeta(x, a=1, b=1, r=1, q=1, log.p=FALSE, lower.tail=TRUE)
varMRbeta(p, a=1, b=1, r=1, q=1, log.p=FALSE, lower.tail=TRUE)
esMRbeta(p, a=1, b=1, r=1, q=1)
```

Arguments

x	scaler or vector of values at which the pdf or cdf needs to be computed
p	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
q	the value of the scale parameter, must be positive, the default is 1
a	the value of the first shape parameter, must be positive, the default is 1
b	the value of the second shape parameter, must be positive, the default is 1

`r`	the value of the third shape parameter, must be positive, the default is 1
`log`	if TRUE then log(pdf) are returned
`log.p`	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
`lower.tail`	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as `x`, giving the pdf or cdf values computed at `x` or an object of the same length as `p`, giving the values at risk or expected shortfall computed at `p`.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dMRbeta(x)
pMRbeta(x)
varMRbeta(x)
esMRbeta(x)
```

`nakagami` *Nakagami distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the Nakagami distribution due to Nakagami (1960) given by

$$\begin{aligned} f(x) &= \frac{2m^m}{\Gamma(m)a^m} x^{2m-1} \exp\left(-\frac{mx^2}{a}\right), \\ F(x) &= 1 - Q\left(m, \frac{mx^2}{a}\right), \\ \mathrm{VaR}_p(X) &= \sqrt{\frac{a}{m}} \sqrt{Q^{-1}(m, 1-p)}, \\ \mathrm{ES}_p(X) &= \frac{\sqrt{a}}{p\sqrt{m}} \int_0^p \sqrt{Q^{-1}(m, 1-v)} dv \end{aligned}$$

for $x > 0$, $0 < p < 1$, $a > 0$, the scale parameter, and $m > 0$, the shape parameter.

Usage

```
dnakagami(x, m=1, a=1, log=FALSE)
pnakagami(x, m=1, a=1, log.p=FALSE, lower.tail=TRUE)
varnakagami(p, m=1, a=1, log.p=FALSE, lower.tail=TRUE)
esnakagami(p, m=1, a=1)
```

Arguments

x	scaler or vector of values at which the pdf or cdf needs to be computed
p	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
a	the value of the scale parameter, must be positive, the default is 1
m	the value of the shape parameter, must be positive, the default is 1
log	if TRUE then log(pdf) are returned
log.p	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
lower.tail	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as x, giving the pdf or cdf values computed at x or an object of the same length as p, giving the values at risk or expected shortfall computed at p.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dnakagami(x)
pnakagami(x)
varnakagami(x)
esnakagami(x)
```

normal *Normal distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the normal distribution due to de Moivre (1738) and Gauss (1809) given by

$$
\begin{aligned}
&f(x) = \frac{1}{\sigma}\phi\left(\frac{x-\mu}{\sigma}\right),\\
&F(x) = \Phi\left(\frac{x-\mu}{\sigma}\right),\\
&\mathrm{VaR}_p(X) = \mu + \sigma\Phi^{-1}(p),\\
&\mathrm{ES}_p(X) = \mu + \frac{\sigma}{p}\int_0^p \Phi^{-1}(v)dv
\end{aligned}
$$

for $-\infty < x < \infty$, $0 < p < 1$, $-\infty < \mu < \infty$, the location parameter, and $\sigma > 0$, the scale parameter, where $\phi(\cdot)$ denotes the pdf of a standard normal random variable, and $\Phi(\cdot)$ denotes the cdf of a standard normal random variable.

Usage

```
dnormal(x, mu=0, sigma=1, log=FALSE)
pnormal(x, mu=0, sigma=1, log.p=FALSE, lower.tail=TRUE)
varnormal(p, mu=0, sigma=1, log.p=FALSE, lower.tail=TRUE)
esnormal(p, mu=0, sigma=1)
```

Arguments

`x`	scaler or vector of values at which the pdf or cdf needs to be computed
`p`	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
`mu`	the value of the location parameter, can take any real value, the default is zero
`sigma`	the value of the scale parameter, must be positive, the default is 1
`log`	if TRUE then log(pdf) are returned
`log.p`	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
`lower.tail`	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as `x`, giving the pdf or cdf values computed at `x` or an object of the same length as `p`, giving the values at risk or expected shortfall computed at `p`.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dnormal(x)
pnormal(x)
varnormal(x)
esnormal(x)
```

`pareto` *Pareto distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the Pareto distribution due to Pareto (1964) given by

$$f(x) = cK^c x^{-c-1},$$
$$F(x) = 1 - \left(\frac{K}{x}\right)^c,$$
$$\mathrm{VaR}_p(X) = K(1-p)^{-1/c},$$
$$\mathrm{ES}_p(X) = \frac{Kc}{p(1-c)}(1-p)^{1-1/c} - \frac{Kc}{p(1-c)}$$

for $x \geq K$, $0 < p < 1$, $K > 0$, the scale parameter, and $c > 0$, the shape parameter.

Usage

```
dpareto(x, K=1, c=1, log=FALSE)
ppareto(x, K=1, c=1, log.p=FALSE, lower.tail=TRUE)
varpareto(p, K=1, c=1, log.p=FALSE, lower.tail=TRUE)
espareto(p, K=1, c=1)
```

Arguments

`x`	scaler or vector of values at which the pdf or cdf needs to be computed
`p`	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
`K`	the value of the scale parameter, must be positive, the default is 1
`c`	the value of the shape parameter, must be positive, the default is 1
`log`	if TRUE then log(pdf) are returned
`log.p`	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
`lower.tail`	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as x, giving the pdf or cdf values computed at x or an object of the same length as p, giving the values at risk or expected shortfall computed at p.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dpareto(x)
ppareto(x)
varpareto(x)
espareto(x)
```

`paretostable` *Pareto positive stable distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the Pareto positive stable distribution due to Sarabia and Prieto (2009) and Guillen et al. (2011) given by

$$\begin{aligned} f(x) &= \frac{\nu\lambda}{x}\left[\log\left(\frac{x}{\sigma}\right)\right]^{\nu-1}\exp\left\{-\lambda\left[\log\left(\frac{x}{\sigma}\right)\right]^{\nu}\right\}, \\ F(x) &= 1-\exp\left\{-\lambda\left[\log\left(\frac{x}{\sigma}\right)\right]^{\nu}\right\}, \\ \mathrm{VaR}_p(X) &= \sigma\exp\left\{\left[-\frac{1}{\lambda}\log(1-p)\right]^{1/\nu}\right\}, \\ \mathrm{ES}_p(X) &= \frac{\sigma}{p}\int_0^p\exp\left\{\left[-\frac{1}{\lambda}\log(1-v)\right]^{1/\nu}\right\}dv \end{aligned}$$

for $x > 0$, $0 < p < 1$, $\lambda > 0$, the first scale parameter, $\sigma > 0$, the second scale parameter, and $\nu > 0$, the shape parameter.

Usage

```
dparetostable(x, lambda=1, nu=1, sigma=1, log=FALSE)
pparetostable(x, lambda=1, nu=1, sigma=1, log.p=FALSE, lower.tail=TRUE)
varparetostable(p, lambda=1, nu=1, sigma=1, log.p=FALSE, lower.tail=TRUE)
esparetostable(p, lambda=1, nu=1, sigma=1)
```

Arguments

x	scaler or vector of values at which the pdf or cdf needs to be computed
p	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
lambda	the value of the first scale parameter, must be positive, the default is 1
sigma	the value of the second scale parameter, must be positive, the default is 1
nu	the value of the shape parameter, must be positive, the default is 1
log	if TRUE then log(pdf) are returned
log.p	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
lower.tail	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as x, giving the pdf or cdf values computed at x or an object of the same length as p, giving the values at risk or expected shortfall computed at p.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dparetostable(x)
pparetostable(x)
varparetostable(x)
esparetostable(x)
```

PCTAlaplace *Poiraud-Casanova-Thomas-Agnan Laplace distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the Poiraud-Casanova-Thomas-Agnan Laplace distribution due to Poiraud-Casanova and Thomas-Agnan (2000) given by

$$f(x) = \begin{cases} a\,(1-a)\exp\left\{(1-a)\,(x-\theta)\right\}, & \text{if } x \leq \theta, \\ \\ a\,(1-a)\exp\left\{a\,(\theta-x)\right\}, & \text{if } x > \theta, \end{cases}$$

$$F(x) = \begin{cases} a\exp\left\{(1-a)\,(x-\theta)\right\}, & \text{if } x \leq \theta, \\ \\ 1-(1-a)\exp\left\{a\,(\theta-x)\right\}, & \text{if } x > \theta, \end{cases}$$

$$\mathrm{VaR}_p(X) = \begin{cases} \theta + \dfrac{1}{1-a}\log\left(\dfrac{p}{a}\right), & \text{if } p \leq a, \\ \\ \theta - \dfrac{1}{a}\log\left(\dfrac{1-p}{1-a}\right), & \text{if } p > a, \end{cases}$$

$$\mathrm{ES}_p(X) = \begin{cases} \theta - \dfrac{\log a}{1-a} + \dfrac{\log p - 1}{(1-a)p}, & \text{if } p \leq a, \\ \\ \theta - \dfrac{1}{a} + \dfrac{1}{p} - \dfrac{a}{(1-a)p} + \dfrac{1-p}{ap}\log\left(\dfrac{1-p}{1-a}\right), & \text{if } p > a \end{cases}$$

for $-\infty < x < \infty$, $0 < p < 1$, $-\infty < \theta < \infty$, the location parameter, and $a > 0$, the scale parameter.

Usage

```
dPCTAlaplace(x, a=0.5, theta=0, log=FALSE)
pPCTAlaplace(x, a=0.5, theta=0, log.p=FALSE, lower.tail=TRUE)
varPCTAlaplace(p, a=0.5, theta=0, log.p=FALSE, lower.tail=TRUE)
esPCTAlaplace(p, a=0.5, theta=0)
```

Arguments

`x`	scaler or vector of values at which the pdf or cdf needs to be computed
`p`	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
`theta`	the value of the location parameter, can take any real value, the default is zero
`a`	the value of the scale parameter, must be in the unit interval, the default is 0.5
`log`	if TRUE then log(pdf) are returned
`log.p`	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
`lower.tail`	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as `x`, giving the pdf or cdf values computed at `x` or an object of the same length as `p`, giving the values at risk or expected shortfall computed at `p`.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dPCTAlaplace(x)
pPCTAlaplace(x)
varPCTAlaplace(x)
esPCTAlaplace(x)
```

---

perks *Perks distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the Perks distribution due to Perks (1932) given by

$$f(x) = \frac{a \exp(bx) \left[1 + a\right]}{\left[1 + a \exp(bx)\right]^2},$$
$$F(x) = 1 - \frac{1 + a}{1 + a \exp(bx)},$$
$$\mathrm{VaR}_p(X) = \frac{1}{b} \log \frac{a + p}{a(1 - p)},$$
$$\mathrm{ES}_p(X) = -\left(1 + \frac{a}{p}\right) \frac{\log a}{b} + \frac{(a + p)\log(a + p)}{bp} + \frac{(1 - p)\log(1 - p)}{bp}$$

for $x > 0$, $0 < p < 1$, $a > 0$, the first scale parameter and $b > 0$, the second scale parameter.

Usage

```
dperks(x, a=1, b=1, log=FALSE)
pperks(x, a=1, b=1, log.p=FALSE, lower.tail=TRUE)
varperks(p, a=1, b=1, log.p=FALSE, lower.tail=TRUE)
esperks(p, a=1, b=1)
```

Arguments

x	scaler or vector of values at which the pdf or cdf needs to be computed
p	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
a	the value of the first scale parameter, must be positive, the default is 1
b	the value of the second scale parameter, must be positive, the default is 1
log	if TRUE then log(pdf) are returned
log.p	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
lower.tail	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as x, giving the pdf or cdf values computed at x or an object of the same length as p, giving the values at risk or expected shortfall computed at p.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dperks(x)
pperks(x)
varperks(x)
esperks(x)
```

---

power1 *Power function I distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the power function I distribution given by

$$f(x) = ax^{a-1},$$
$$F(x) = x^a,$$
$$\mathrm{VaR}_p(X) = p^{1/a},$$
$$\mathrm{ES}_p(X) = \frac{p^{1/a}}{1/a+1}$$

for $0 < x < 1$, $0 < p < 1$, and $a > 0$, the shape parameter.

Usage

```
dpower1(x, a=1, log=FALSE)
ppower1(x, a=1, log.p=FALSE, lower.tail=TRUE)
varpower1(p, a=1, log.p=FALSE, lower.tail=TRUE)
espower1(p, a=1)
```

Arguments

x	scaler or vector of values at which the pdf or cdf needs to be computed
p	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
a	the value of the shape parameter, must be positive, the default is 1
log	if TRUE then log(pdf) are returned
log.p	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
lower.tail	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as x, giving the pdf or cdf values computed at x or an object of the same length as p, giving the values at risk or expected shortfall computed at p.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dpower1(x)
ppower1(x)
varpower1(x)
espower1(x)
```

power2 *Power function II distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the power function II distribution given by

$$f(x) = b(1-x)^{b-1},$$
$$F(x) = 1-(1-x)^{b},$$
$$\mathrm{VaR}_p(X) = 1-(1-p)^{1/b},$$
$$\mathrm{ES}_p(X) = 1 + \frac{b\left[(1-p)^{1/b+1}-1\right]}{p(b+1)}$$

for $0 < x < 1$, $0 < p < 1$, and $b > 0$, the shape parameter.

Usage

```
dpower2(x, b=1, log=FALSE)
ppower2(x, b=1, log.p=FALSE, lower.tail=TRUE)
varpower2(p, b=1, log.p=FALSE, lower.tail=TRUE)
espower2(p, b=1)
```

Arguments

x	scaler or vector of values at which the pdf or cdf needs to be computed
p	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
b	the value of the shape parameter, must be positive, the default is 1
log	if TRUE then log(pdf) are returned
log.p	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
lower.tail	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as x, giving the pdf or cdf values computed at x or an object of the same length as p, giving the values at risk or expected shortfall computed at p.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dpower2(x)
ppower2(x)
varpower2(x)
espower2(x)
```

---

quad *Quadratic distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the quadratic distribution given by

$$f(x) = \alpha (x-\beta)^2,$$
$$F(x) = \frac{\alpha}{3}\left[(x-\beta)^3 + (\beta-a)^3\right],$$
$$\mathrm{VaR}_p(X) = \beta + \left[\frac{3p}{\alpha} - (\beta-a)^3\right]^{1/3},$$
$$\mathrm{ES}_p(X) = \beta + \frac{\alpha}{4p}\left\{\left[\frac{3p}{\alpha} - (\beta-a)^3\right]^{4/3} - (\beta-a)^4\right\}$$

for $a \leq x \leq b$, $0 < p < 1$, $-\infty < a < \infty$, the first location parameter, and $-\infty < a < b < \infty$, the second location parameter, where $\alpha = \frac{12}{(b-a)^3}$ and $\beta = \frac{a+b}{2}$.

Usage

```
dquad(x, a=0, b=1, log=FALSE)
pquad(x, a=0, b=1, log.p=FALSE, lower.tail=TRUE)
varquad(p, a=0, b=1, log.p=FALSE, lower.tail=TRUE)
esquad(p, a=0, b=1)
```

Arguments

x	scaler or vector of values at which the pdf or cdf needs to be computed
p	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
a	the value of the first location parameter, can take any real value, the default is zero
b	the value of the second location parameter, can take any real value but must be greater than a, the default is 1
log	if TRUE then log(pdf) are returned
log.p	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
lower.tail	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as x, giving the pdf or cdf values computed at x or an object of the same length as p, giving the values at risk or expected shortfall computed at p.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dquad(x)
pquad(x)
varquad(x)
esquad(x)
```

---

rgamma *Reflected gamma distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the reflected gamma distribution due to Borgi (1965) given by

$$f(x) = \frac{1}{2\phi\Gamma(a)} \left| \frac{x-\theta}{\phi} \right|^{a-1} \exp\left\{ - \left| \frac{x-\theta}{\phi} \right| \right\},$$

$$F(x) = \begin{cases} \frac{1}{2} Q\left(a, \frac{\theta - x}{\phi}\right), & \text{if } x \leq \theta, \\ 1 - \frac{1}{2} Q\left(a, \frac{x-\theta}{\phi}\right), & \text{if } x > \theta, \end{cases}$$

$$\mathrm{VaR}_p(X) = \begin{cases} \theta - \phi Q^{-1}(a, 2p), & \text{if } p \leq 1/2, \\ \theta + \phi Q^{-1}(a, 2(1-p)), & \text{if } p > 1/2, \end{cases}$$

$$\mathrm{ES}_p(X) = \begin{cases} \theta - \frac{\phi}{p} \int_0^p Q^{-1}(a, 2v)\, dv, & \text{if } p \leq 1/2, \\ \theta - \frac{\phi}{p} \int_0^{1/2} Q^{-1}(a, 2v)\, dv + \frac{\phi}{p} \int_{1/2}^p Q^{-1}(a, 2(1-v))\, dv, & \text{if } p > 1/2 \end{cases}$$

for $-\infty < x < \infty$, $0 < p < 1$, $-\infty < \theta < \infty$, the location parameter, $\phi > 0$, the scale parameter, and $a > 0$, the shape parameter.

Usage

```
drgamma(x, a=1, theta=0, phi=1, log=FALSE)
prgamma(x, a=1, theta=0, phi=1, log.p=FALSE, lower.tail=TRUE)
varrgamma(p, a=1, theta=0, phi=1, log.p=FALSE, lower.tail=TRUE)
esrgamma(p, a=1, theta=0, phi=1)
```

Arguments

x	scaler or vector of values at which the pdf or cdf needs to be computed
p	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
theta	the value of the location parameter, can take any real value, the default is zero
phi	the value of the scale parameter, must be positive, the default is 1
a	the value of the shape parameter, must be positive, the default is 1
log	if TRUE then log(pdf) are returned
log.p	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
lower.tail	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as x, giving the pdf or cdf values computed at x or an object of the same length as p, giving the values at risk or expected shortfall computed at p.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
drgamma(x)
prgamma(x)
varrgamma(x)
esrgamma(x)
```

RS *Ramberg-Schmeiser distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the Ramber-Schmeiser distribution due to Ramberg and Schmeiser (1974) given by

$$\begin{aligned} \mathrm{VaR}_p(X) &= \frac{p^b - (1-p)^c}{d}, \\ \mathrm{ES}_p(X) &= \frac{p^b}{d(b+1)} + \frac{(1-p)^{c+1} - 1}{pd(c+1)} \end{aligned}$$

for $0 < p < 1$, $b > 0$, the first shape parameter, $c > 0$, the second shape parameter, and $d > 0$, the scale parameter.

Usage

```
varRS(p, b=1, c=1, d=1, log.p=FALSE, lower.tail=TRUE)
esRS(p, b=1, c=1, d=1)
```

Arguments

`p`	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
`d`	the value of the scale parameter, must be positive, the default is 1
`b`	the value of the first shape parameter, must be positive, the default is 1
`c`	the value of the second shape parameter, must be positive, the default is 1
`log`	if TRUE then log(pdf) are returned
`log.p`	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
`lower.tail`	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as `x`, giving the pdf or cdf values computed at `x` or an object of the same length as `p`, giving the values at risk or expected shortfall computed at `p`.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
varRS(x)
esRS(x)
```

---

schabe *Schabe distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the Schabe distribution due to Schabe (1994) given by

$$f(x) = \frac{2\gamma + (1-\gamma)x/\theta}{\theta(\gamma + x/\theta)^2},$$
$$F(x) = \frac{(1+\gamma)x}{x + \gamma\theta},$$
$$\mathrm{VaR}_p(X) = \frac{p\gamma\theta}{1+\gamma-p},$$
$$\mathrm{ES}_p(X) = -\theta\gamma - \frac{\theta\gamma(1+\gamma)}{p}\log\frac{1+\gamma-p}{1+\gamma}$$

for $x > 0$, $0 < p < 1$, $0 < \gamma < 1$, the first scale parameter, and $\theta > 0$, the second scale parameter.

Usage

```
dschabe(x, gamma=0.5, theta=1, log=FALSE)
pschabe(x, gamma=0.5, theta=1, log.p=FALSE, lower.tail=TRUE)
varschabe(p, gamma=0.5, theta=1, log.p=FALSE, lower.tail=TRUE)
esschabe(p, gamma=0.5, theta=1)
```

Arguments

`x`	scaler or vector of values at which the pdf or cdf needs to be computed
`p`	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
`gamma`	the value of the first scale parameter, must be in the unit interval, the default is 0.5
`theta`	the value of the second scale parameter, must be positive, the default is 1
`log`	if TRUE then log(pdf) are returned
`log.p`	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
`lower.tail`	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as `x`, giving the pdf or cdf values computed at `x` or an object of the same length as `p`, giving the values at risk or expected shortfall computed at `p`.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dschabe(x)
pschabe(x)
varschabe(x)
esschabe(x)
```

---

secant *Hyperbolic secant distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the hyperbolic secant distribution given by

$$f(x) = \frac{1}{2}\mathrm{sech}\left(\frac{\pi x}{2}\right),$$
$$F(x) = \frac{2}{\pi}\arctan\left[\exp\left(\frac{\pi x}{2}\right)\right],$$
$$\mathrm{VaR}_p(X) = \frac{2}{\pi}\log\left[\tan\left(\frac{\pi p}{2}\right)\right],$$
$$\mathrm{ES}_p(X) = \frac{2}{\pi p}\int_0^p \log\left[\tan\left(\frac{\pi v}{2}\right)\right] dv$$

for $-\infty < x < \infty$, and $0 < p < 1$.

Usage

```
dsecant(x, log=FALSE)
psecant(x, log.p=FALSE, lower.tail=TRUE)
varsecant(p, log.p=FALSE, lower.tail=TRUE)
essecant(p)
```

Arguments

x	scaler or vector of values at which the pdf or cdf needs to be computed
p	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
log	if TRUE then log(pdf) are returned
log.p	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
lower.tail	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as x, giving the pdf or cdf values computed at x or an object of the same length as p, giving the values at risk or expected shortfall computed at p.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dsecant(x)
psecant(x)
varsecant(x)
essecant(x)
```

`stacygamma` *Stacy distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for Stacy distribution due to Stacy (1962) given by

$$f(x) = \frac{c x^{c\gamma-1} \exp\left[-(x/\theta)^c\right]}{\theta^{c\gamma}\Gamma(\gamma)},$$
$$F(x) = 1 - Q\left(\gamma, \left(\frac{x}{\theta}\right)^c\right),$$
$$\mathrm{VaR}_p(X) = \theta\left[Q^{-1}(\gamma, 1-p)\right]^{1/c},$$
$$\mathrm{ES}_p(X) = \frac{\theta}{p}\int_0^p \left[Q^{-1}(\gamma, 1-v)\right]^{1/c} dv$$

for $x > 0$, $0 < p < 1$, $\theta > 0$, the scale parameter, $c > 0$, the first shape parameter, and $\gamma > 0$, the second shape parameter.

Usage

```
dstacygamma(x, gamma=1, c=1, theta=1, log=FALSE)
pstacygamma(x, gamma=1, c=1, theta=1, log.p=FALSE, lower.tail=TRUE)
varstacygamma(p, gamma=1, c=1, theta=1, log.p=FALSE, lower.tail=TRUE)
esstacygamma(p, gamma=1, c=1, theta=1)
```

Arguments

`x`	scaler or vector of values at which the pdf or cdf needs to be computed
`p`	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
`theta`	the value of the scale parameter, must be positive, the default is 1
`c`	the value of the first scale parameter, must be positive, the default is 1
`gamma`	the value of the second scale parameter, must be positive, the default is 1
`log`	if TRUE then log(pdf) are returned
`log.p`	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
`lower.tail`	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as `x`, giving the pdf or cdf values computed at `x` or an object of the same length as `p`, giving the values at risk or expected shortfall computed at `p`.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dstacygamma(x)
pstacygamma(x)
varstacygamma(x)
esstacygamma(x)
```

T   *Student's t distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the Student's t distribution due to Gosset (1908) given by

$$
\begin{aligned}
f(x) &= \frac{\Gamma\left(\frac{n+1}{2}\right)}{\sqrt{n\pi}\Gamma\left(\frac{n}{2}\right)}\left(1+\frac{x^2}{n}\right)^{-\frac{n+1}{2}}, \\
F(x) &= \frac{1+\mathrm{sign}(x)}{2} - \frac{\mathrm{sign}(x)}{2} I_{\frac{n}{x^2+n}}\left(\frac{n}{2},\frac{1}{2}\right), \\
\mathrm{VaR}_p(X) &= \sqrt{n}\mathrm{sign}\left(p-\frac{1}{2}\right)\sqrt{\frac{1}{I_a^{-1}\left(\frac{n}{2},\frac{1}{2}\right)}-1}, \\
&\text{where } a = 2p \text{ if } p < 1/2,\ a = 2(1-p) \text{ if } p \geq 1/2, \\
\mathrm{ES}_p(X) &= \frac{\sqrt{n}}{p}\int_0^p \mathrm{sign}\left(v-\frac{1}{2}\right)\sqrt{\frac{1}{I_a^{-1}\left(\frac{n}{2},\frac{1}{2}\right)}-1dv}, \\
&\text{where } a = 2v \text{ if } v < 1/2,\ a = 2(1-v) \text{ if } v \geq 1/2
\end{aligned}
$$

for $-\infty < x < \infty$, $0 < p < 1$, and $n > 0$, the degree of freedom parameter.

Usage

```
dT(x, n=1, log=FALSE)
pT(x, n=1, log.p=FALSE, lower.tail=TRUE)
varT(p, n=1, log.p=FALSE, lower.tail=TRUE)
esT(p, n=1)
```

Arguments

`x`	scaler or vector of values at which the pdf or cdf needs to be computed
`p`	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
`n`	the value of the degree of freedom parameter, must be positive, the default is 1
`log`	if TRUE then log(pdf) are returned
`log.p`	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
`lower.tail`	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as `x`, giving the pdf or cdf values computed at `x` or an object of the same length as `p`, giving the values at risk or expected shortfall computed at `p`.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dT(x)
pT(x)
varT(x)
esT(x)
```

TL *Tukey-Lambda distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the Tukey-Lambda distribution due to Tukey (1962) given by

$$\mathrm{VaR}_p(X) = \frac{p^{\lambda} - (1-p)^{\lambda}}{\lambda},$$
$$\mathrm{ES}_p(X) = \frac{p^{\lambda+1} + (1-p)^{\lambda+1} - 1}{p\lambda(\lambda+1)}$$

for $0 < p < 1$, and $\lambda > 0$, the shape parameter.

Usage

```
varTL(p, lambda=1, log.p=FALSE, lower.tail=TRUE)
esTL(p, lambda=1)
```

Arguments

`p`	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
`lambda`	the value of the shape parameter, must be positive, the default is 1
`log`	if TRUE then log(pdf) are returned
`log.p`	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
`lower.tail`	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as `x`, giving the pdf or cdf values computed at `x` or an object of the same length as `p`, giving the values at risk or expected shortfall computed at `p`.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
varTL(x)
esTL(x)
```

TL2 *Topp-Leone distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the Topp-Leone distribution due to Topp and Leone (1955) given by

$$f(x) = 2b(x(2-x))^{b-1}(1-x),$$
$$F(x) = (x(2-x))^b,$$
$$\mathrm{VaR}_p(X) = 1 - \sqrt{1-p^{1/b}},$$
$$\mathrm{ES}_p(X) = 1 - \frac{b}{p} B_{p^{1/b}}\left(b, \frac{3}{2}\right)$$

for $x > 0$, $0 < p < 1$, and $b > 0$, the shape parameter.

Usage

```
dTL2(x, b=1, log=FALSE)
pTL2(x, b=1, log.p=FALSE, lower.tail=TRUE)
varTL2(p, b=1, log.p=FALSE, lower.tail=TRUE)
esTL2(p, b=1)
```

Arguments

`x`	scaler or vector of values at which the pdf or cdf needs to be computed
`p`	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
`b`	the value of the shape parameter, must be positive, the default is 1
`log`	if TRUE then log(pdf) are returned
`log.p`	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
`lower.tail`	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as `x`, giving the pdf or cdf values computed at `x` or an object of the same length as `p`, giving the values at risk or expected shortfall computed at `p`.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dTL2(x)
pTL2(x)
varTL2(x)
esTL2(x)
```

`triangular` *Triangular distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the triangular distribution given by

$$f(x) = \begin{cases} 0, & \text{if } x < a, \\ \dfrac{2(x-a)}{(b-a)(c-a)}, & \text{if } a \le x \le c, \\ \dfrac{2(b-x)}{(b-a)(b-c)}, & \text{if } c < x \le b, \\ 0, & \text{if } b < x, \end{cases}$$

$$F(x) = \begin{cases} 0, & \text{if } x < a, \\ \dfrac{(x-a)^2}{(b-a)(c-a)}, & \text{if } a \le x \le c, \\ 1 - \dfrac{(b-x)^2}{(b-a)(b-c)}, & \text{if } c < x \le b, \\ 1, & \text{if } b < x, \end{cases}$$

$$\mathrm{VaR}_p(X) = \begin{cases} a + \sqrt{p(b-a)(c-a)}, & \text{if } 0 < p < \frac{c-a}{b-a}, \\ b - \sqrt{(1-p)(b-a)(b-c)}, & \text{if } \frac{c-a}{b-a} \le p < 1, \end{cases}$$

$$\mathrm{ES}_p(X) = \begin{cases} a + \dfrac{2}{3}\sqrt{p(b-a)(c-a)}, & \text{if } 0 < p < \frac{c-a}{b-a}, \\ b + \dfrac{a-c}{p} + \dfrac{2(2c-a-b)}{3p} + 2\sqrt{(b-a)(b-c)}\dfrac{(1-p)^{3/2}}{3p}, & \text{if } \frac{c-a}{b-a} \le p < 1 \end{cases}$$

for $a \le x \le b$, $0 < p < 1$, $-\infty < a < \infty$, the first location parameter, $-\infty < a < c < \infty$, the second location parameter, and $-\infty < c < b < \infty$, the third location parameter.

Usage

```
dtriangular(x, a=0, b=2, c=1, log=FALSE)
ptriangular(x, a=0, b=2, c=1, log.p=FALSE, lower.tail=TRUE)
vartriangular(p, a=0, b=2, c=1, log.p=FALSE, lower.tail=TRUE)
estriangular(p, a=0, b=2, c=1)
```

Arguments

x	scaler or vector of values at which the pdf or cdf needs to be computed
p	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
a	the value of the first location parameter, can take any real value, the default is zero

c	the value of the second location parameter, can take any real value but must be greater than a, the default is 1
b	the value of the third location parameter, can take any real value but must be greater than c, the default is 2
log	if TRUE then log(pdf) are returned
log.p	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
lower.tail	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as x, giving the pdf or cdf values computed at x or an object of the same length as p, giving the values at risk or expected shortfall computed at p.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dtriangular(x)
ptriangular(x)
vartriangular(x)
estriangular(x)
```

---

tsp *Two sided power distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the two sided power distribution due to van Dorp and Kotz (2002) given by

$$f(x) = \begin{cases} a\left(\frac{x}{\theta}\right)^{a-1}, & \text{if } 0 < x \leq \theta, \\ a\left(\frac{1-x}{1-\theta}\right)^{a-1}, & \text{if } \theta < x < 1, \end{cases}$$

$$F(x) = \begin{cases} \theta\left(\frac{x}{\theta}\right)^{a}, & \text{if } 0 < x \leq \theta, \\ 1-(1-\theta)\left(\frac{1-x}{1-\theta}\right)^{a}, & \text{if } \theta < x < 1, \end{cases}$$

$$\mathrm{VaR}_p(X) = \begin{cases} \theta\left(\frac{p}{\theta}\right)^{1/a}, & \text{if } 0 < p \leq \theta, \\ 1-(1-\theta)\left(\frac{1-p}{1-\theta}\right)^{1/a}, & \text{if } \theta < p < 1, \end{cases}$$

$$\mathrm{ES}_p(X) = \begin{cases} \frac{a\theta}{a+1}\left(\frac{p}{\theta}\right)^{1/a}, & \text{if } 0 < p \leq \theta, \\ 1-\frac{\theta}{p}+\frac{a(2\theta-1)}{(a+1)p}+\frac{a(1-\theta)^2}{(a+1)p}\left(\frac{1-p}{1-\theta}\right)^{1+1/a}, & \text{if } \theta < p < 1 \end{cases}$$

for $0 < x < 1$, $0 < p < 1$, $a > 0$, the shape parameter, and $-\infty < \theta < \infty$, the location parameter.

Usage

```
dtsp(x, a=1, theta=0.5, log=FALSE)
ptsp(x, a=1, theta=0.5, log.p=FALSE, lower.tail=TRUE)
vartsp(p, a=1, theta=0.5, log.p=FALSE, lower.tail=TRUE)
estsp(p, a=1, theta=0.5)
```

Arguments

`x`	scaler or vector of values at which the pdf or cdf needs to be computed
`p`	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
`theta`	the value of the location parameter, must take a value in the unit interval, the default is 0.5
`a`	the value of the shape parameter, must be positive, the default is 1
`log`	if TRUE then log(pdf) are returned
`log.p`	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
`lower.tail`	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as `x`, giving the pdf or cdf values computed at `x` or an object of the same length as `p`, giving the values at risk or expected shortfall computed at `p`.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dtsp(x)
ptsp(x)
vartsp(x)
estsp(x)
```

`uniform` *Uniform distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the uniform distribution given by

$$f(x) = \frac{1}{b-a},$$
$$F(x) = \frac{x-a}{b-a},$$
$$\mathrm{VaR}_p(X) = a + p(b-a),$$
$$\mathrm{ES}_p(X) = a + \frac{p}{2}(b-a)$$

for $a < x < b$, $0 < p < 1$, $-\infty < a < \infty$, the first location parameter, and $-\infty < a < b < \infty$, the second location parameter.

Usage

```
duniform(x, a=0, b=1, log=FALSE)
puniform(x, a=0, b=1, log.p=FALSE, lower.tail=TRUE)
varuniform(p, a=0, b=1, log.p=FALSE, lower.tail=TRUE)
esuniform(p, a=0, b=1)
```

Arguments

x	scaler or vector of values at which the pdf or cdf needs to be computed
p	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
a	the value of the first location parameter, can take any real value, the default is zero

`b`	the value of the second location parameter, can take any real value but must be greater than a, the default is 1
`log`	if TRUE then log(pdf) are returned
`log.p`	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
`lower.tail`	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as `x`, giving the pdf or cdf values computed at `x` or an object of the same length as `p`, giving the values at risk or expected shortfall computed at `p`.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
duniform(x)
puniform(x)
varuniform(x)
esuniform(x)
```

`weibull` *Weibull distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the Weibull distribution due to Weibull (1951) given by

$$
\begin{aligned}
& f(x) = \frac{\alpha x^{\alpha - 1}}{\sigma^\alpha} \exp \left\{ - \left(\frac{x}{\sigma} \right)^\alpha \right\}, \\
& F(x) = 1 - \exp \left\{ - \left(\frac{x}{\sigma} \right)^\alpha \right\}, \\
& \mathrm{VaR}_p(X) = \sigma \left[- \log(1 - p) \right]^{1/\alpha}, \\
& \mathrm{ES}_p(X) = \frac{\sigma}{p} \gamma \left(1 + 1/\alpha, - \log(1 - p) \right)
\end{aligned}
$$

for $x > 0$, $0 < p < 1$, $\alpha > 0$, the shape parameter, and $\sigma > 0$, the scale parameter.

Usage

```
dWeibull(x, alpha=1, sigma=1, log=FALSE)
pWeibull(x, alpha=1, sigma=1, log.p=FALSE, lower.tail=TRUE)
varWeibull(p, alpha=1, sigma=1, log.p=FALSE, lower.tail=TRUE)
esWeibull(p, alpha=1, sigma=1)
```

Arguments

x	scaler or vector of values at which the pdf or cdf needs to be computed
p	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
sigma	the value of the scale parameter, must be positive, the default is 1
alpha	the value of the shape parameter, must be positive, the default is 1
log	if TRUE then log(pdf) are returned
log.p	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
lower.tail	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as x, giving the pdf or cdf values computed at x or an object of the same length as p, giving the values at risk or expected shortfall computed at p.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dWeibull(x)
pWeibull(x)
varWeibull(x)
esWeibull(x)
```

xie *Xie distribution*

Description

Computes the pdf, cdf, value at risk and expected shortfall for the Xie distribution due to Xie et al. (2002) given by

$$f(x) = \lambda b \left(\frac{x}{a}\right)^{b-1} \exp\left[(x/a)^b\right] \exp(\lambda a) \exp\left\{-\lambda a \exp\left[(x/a)^b\right]\right\},$$
$$F(x) = 1 - \exp(\lambda a) \exp\left\{-\lambda a \exp\left[(x/a)^b\right]\right\},$$
$$\mathrm{VaR}_p(X) = a \left\{\log\left[1 - \frac{\log(1-p)}{\lambda a}\right]\right\}^{1/b},$$
$$\mathrm{ES}_p(X) = \frac{a}{p} \int_0^p \left\{\log\left[1 - \frac{\log(1-v)}{\lambda a}\right]\right\}^{1/b} dv$$

for $x > 0$, $0 < p < 1$, $a > 0$, the first scale parameter, $b > 0$, the shape parameter, and $\lambda > 0$, the second scale parameter.

Usage

```
dxie(x, a=1, b=1, lambda=1, log=FALSE)
pxie(x, a=1, b=1, lambda=1, log.p=FALSE, lower.tail=TRUE)
varxie(p, a=1, b=1, lambda=1, log.p=FALSE, lower.tail=TRUE)
esxie(p, a=1, b=1, lambda=1)
```

Arguments

`x`	scaler or vector of values at which the pdf or cdf needs to be computed
`p`	scaler or vector of values at which the value at risk or expected shortfall needs to be computed
`a`	the value of the first scale parameter, must be positive, the default is 1
`lambda`	the value of the second scale parameter, must be positive, the default is 1
`b`	the value of the shape parameter, must be positive, the default is 1
`log`	if TRUE then log(pdf) are returned
`log.p`	if TRUE then log(cdf) are returned and quantiles are computed for exp(p)
`lower.tail`	if FALSE then 1-cdf are returned and quantiles are computed for 1-p

Value

An object of the same length as `x`, giving the pdf or cdf values computed at `x` or an object of the same length as `p`, giving the values at risk or expected shortfall computed at `p`.

Author(s)

Saralees Nadarajah

References

Stephen Chan, Saralees Nadarajah & Emmanuel Afuecheta (2016). An R Package for Value at Risk and Expected Shortfall, Communications in Statistics - Simulation and Computation, 45:9, 3416-3434, doi:10.1080/03610918.2014.944658

Examples

```
x=runif(10,min=0,max=1)
dxie(x)
pxie(x)
varxie(x)
esxie(x)
```

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