Package 'mev'

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Title Multivariate Extreme Value Distributions

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Description Exact simulation from max-
stable processes and multivariate extreme value distributions for various parametric models.

License GPL-3

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mev-package *Multivariate Extreme Value Distributions*

Description

Exact simulation from max-stable processes and multivariate extreme value distributions for various parametric models.

Details

The package allows exact generation of multivariate extreme value vectors or max-stable processes. For the latter, the user can provide a variogram function along with a set of locations that serve as input. Models implemented include the 1-parameter logistic and negative logistic as described in the article, the bilogistic and Coles and Tawn extremal Dirichlet model using the algorithm of Boldi (2009) and the Dirichlet mixture. The extremal Student and Husler-Reiss (Brown-Resnick) models are also implemented.

A Dirichlet and a multinormal generator are part of the internal functions and are exported.

Author(s)

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References

Dombry, Engelke and Oesting (2015) Exact simulation of max-stable processes *arXiv:1506.04430v1*, 1–24.

Boldi (2009). A note on the representation of parametric models for multivariate extremes. *Extremes* **12**, 211–218.

mvrnorm *Multivariate Normal distribution sampler*

Description

Sampler derived using the eigendecomposition of the covariance matrix `Sigma`. The function uses the Armadillo random normal generator

Usage

```
mvrnorm(n, mu, Sigma)
```

Arguments

n	sample size
mu	mean vector. Will set the dimension
Sigma	a square covariance matrix, of same dimension as mu. No sanity check is performed to validate that the matrix is p.s.d., so use at own risk

Value

an n sample from a multivariate Normal distribution

Examples

```
mvrnorm(n=10, mu=c(0,2), Sigma=diag(2))
```

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rdir *Random variate generation for Dirichlet distribution on S_d*

Description

A function to sample Dirichlet random variables, based on the representation as ratios of Gamma. Note that the RNG will generate on the full simplex and the sum to one constraint is respected here

Usage

```
rdir(n, alpha, normalize = TRUE)
```

Arguments

n	sample size
alpha	vector of parameter
normalize	boolean. If FALSE, the function returns Gamma variates with parameter alpha.

Value

sample of dimension d (size of alpha) from the Dirichlet distribution.

Examples

```
rdir(n=100, alpha=c(0.5,0.5,2),TRUE)
rdir(n=100, alpha=c(3,1,2),FALSE)
```

rmev *Exact simulations of multivariate extreme value distributions*

Description

Implementation of the random number generators for multivariate extreme-value distributions and max-stable processes based on the two algorithms described in Dombry, Engelke and Oesting (2015).

Usage

```
rmev(n, d, param, asy, sigma, model = c("log", "alog", "neglog", "aneglog",
  "bilog", "negbilog", "hr", "xstud", "smith", "ct", "dirmix"), alg = c("ef",
  "sm"), weights, vario, loc, grid = FALSE)
```

Arguments

n	number of observations
d	dimension of sample
param	parameter vector for the logistic, bilogistic, negative bilogistic and extremal Dirichlet (Coles and Tawn) model. Parameter matrix for the Dirichlet mixture. Degree of freedoms for extremal student model.
asy	list of asymmetry parameters, as in rmvevd, of $2^d - 1$ vectors of size corresponding to the power set of d, with sum to one constraints.
sigma	covariance matrix for Husler-Reiss and extremal Student-t distributions
model	choice between 1-parameter logistic and negative logistic, asymmetric logistic and negative logistic, bilogistic and the extremal Dirichlet model of Coles and Tawn, the Brown-Resnick (which generate the Husler-Reiss MEV distribution), Smith and extremal Student max-stable process , or the Dirichlet mixture.
alg	algorithm, either simulation via extremal function or via the spectral measure. The extremal Dirichlet model is only implemented with sm.
weights	vector of length m for the m mixture components. Must sum to one
vario	function specifying the variogram. Used only if provided in conjonction with loc and if sigma is missing
loc	d by k matrix of location, used as input in the variogram vario or as parameter for the Smith model. If grid is TRUE, unique entries should be supplied.
grid	Logical. TRUE if the coordinates are two-dimensional grid points (spatial models).

Details

The vector param differs depending on the model

- log: one dimensional parameter greater than 1

- `alog`: $2^d - d - 1$ dimensional parameter for `dep`. Values are recycled if needed.
- `neglog`: one dimensional positive parameter
- `aneglog`: $2^d - d - 1$ dimensional parameter for `dep`. Values are recycled if needed.
- `bilog`: `d`-dimensional vector of parameters in $[0, 1]$
- `negbilog`: `d`-dimensional vector of negative parameters
- `ct`: `d`-dimensional vector of positive (a)symmetry parameters. Alternatively, a $d + 1$ vector consisting of the `d` Dirichlet parameters and the last entry is an index of regular variation in `(0, 1]` treated as scale
- `xstud`: one dimensional parameter corresponding to degrees of freedom `alpha`
- `dirmix`: `d` by `m`-dimensional matrix of positive (a)symmetry parameters

Value

an `n` by `d` exact sample from the corresponding multivariate extreme value model

Author(s)

Leo Belzile

References

Dombry, Engelke and Oesting (2015). Exact simulation of max-stable processes, *arXiv:1506.04430v1*, 1–24.

See Also

rmevspec, rmvevd, rbvevd

Examples

```
set.seed(1)
rmev(n=100, d=3, param=2.5, model="log", alg="ef")
rmev(n=100, d=4, param=c(0.2,0.1,0.9,0.5), model="bilog", alg="sm")
## Spatial example using variogram, from Clement Dombry
#Variogram gamma(h) = scale*||h||^alpha
scale <- 0.5; alpha <- 1
vario <- function(x) scale*sqrt(sum(x^2))^alpha
#grid specification
grid.loc <- as.matrix(expand.grid(runif(4), runif(4)))
rmev(n=100, vario=vario,loc=grid.loc, model="hr")
#Example with a grid (generating an array)
rmev(n=10, sigma=cbind(c(2,1),c(1,3)), loc=cbind(runif(4),runif(4)),model="smith", grid=TRUE)
## Example with Dirichlet mixture
alpha.mat <- cbind(c(2,1,1),c(1,2,1),c(1,1,2))
rmev(n=100, param=alpha.mat, weights=rep(1/3,3), model="dirmix")
```

`rmevspec` *Random samples from spectral distributions of multivariate extreme value models.*

Description

Generate from Q_i, the spectral measure of a given multivariate extreme value model

Usage

```
rmevspec(n, d, param, sigma, model = c("log", "neglog", "bilog", "negbilog",
  "hr", "xstud", "ct", "dirmix"), weights, vario, loc)
```

Arguments

`n`	number of observations
`d`	dimension of sample
`param`	parameter vector for the logistic, bilogistic, negative bilogistic and Dirichlet (Coles and Tawn) model. Parameter matrix for the Dirichlet mixture. Degree of freedoms for extremal student model.
`sigma`	covariance matrix for Husler-Reiss and extremal Student-t distributions
`model`	choice between 1-parameter logistic and negative logistic, bilogistic, negative bilogistic and extremal Dirichlet, the Brown-Resnick and extremal Student max-stable process (which generate the Husler-Reiss MEV distribution), or the Dirichlet mixture.
`weights`	vector of length `m` for the `m` mixture components. Must sum to one
`vario`	function specifying the variogram. Used only if provided in conjonction with `loc` and if `sigma` is missing
`loc`	`d` by `k` matrix of location, used as input in the variogram `vario` or as parameter in the Smith `smith` model.

Details

The vector param differs depending on the model

- `log`: one dimensional parameter greater than 1
- `neglog`: one dimensional positive parameter
- `bilog`: `d`-dimensional vector of parameters in $[0, 1]$
- `negbilog`: `d`-dimensional vector of negative parameters
- `ct`: `d`-dimensional vector of positive (a)symmetry parameters. Alternatively, a $d + 1$ vector consisting of the `d` Dirichlet parameters and the last entry is an index of regular variation in `(0, 1]` treated as scale
- `xstud`: one dimensional parameter corresponding to degrees of freedom `alpha`
- `dirmix`: `d` by `m`-dimensional matrix of positive (a)symmetry parameters

Value

an n by d exact sample from the corresponding multivariate extreme value model

Author(s)

Leo Belzile

References

Dombry, Engelke and Oesting (2015). Exact simulation of max-stable processes, *arXiv:1506.04430v1*, 1–24.

Boldi (2009). A note on the representation of parametric models for multivariate extremes. *Extremes* **12**, 211–218.

Examples

```
set.seed(1)
rmevspec(n=100, d=3, param=2.5, model="log")
rmevspec(n=100, d=3, param=2.5, model="neglog")
rmevspec(n=100, d=4, param=c(0.2,0.1,0.9,0.5), model="bilog")
rmevspec(n=100, d=2, param=c(0.8,1.2), model="ct") #Dirichlet model
rmevspec(n=100, d=2, param=c(0.8,1.2,0.5), model="ct") #with additional scale parameter
#Variogram gamma(h) = scale*||h||^alpha
scale <- 0.5; alpha <- 1
vario <- function(x) scale*sqrt(sum(x^2))^alpha
#grid specification
grid.loc <- as.matrix(expand.grid(runif(4), runif(4)))
rmevspec(n=100, vario=vario,loc=grid.loc, model="hr")
## Example with Dirichlet mixture
alpha.mat <- cbind(c(2,1,1),c(1,2,1),c(1,1,2))
rmevspec(n=100, param=alpha.mat, weights=rep(1/3,3), model="dirmix")
```

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