Package 'NCSCopula'

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Title Non-Central Squared Copula Models Estimation

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Description Inference and dependence measure for the non-central squared Gaussian, Student, Clayton, Gumbel, and Frank copula models.The description of the methodology is taken from Section 3 of Nasri, Remillard and Bouezmarni (2019) <doi:10.1016/j.jmva.2019.03.007>.

Depends copula

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copulaEmp *Empirical copula*

Description

This function computes the empirical bivariate copula at a series of points.

Usage

```
copulaEmp(u, U)
```

Arguments

u	(nx2) data matrix of points.
U	(nx2) data matrix of pseudo-observations.

Value

cdf	Empirical copula values at u.

Author(s)

Bouchra R. Nasri, August 14, 2019

Examples

```
param <- c(0.8, 2.5, 0.7) ;
U <- SimNCSCop('Clayton', 250, param)
u = matrix(c(0.2,0.6,0.3,0.5,0.7,0.9),ncol=2,byrow=TRUE);
cdf=copulaEmp(u,U);
```

EstNCSCop *Estimation of a non-central squared copula model*

Description

This function estimates the copula parameter and the non-centrality parameters of a non-central squared copula

Usage

```
EstNCSCop(y, family, p = 2, InitialValues = NULL)
```

Arguments

y	(nx2) data matrix (observations or residuals) that will be transformed to pseudo-observations
family	'Gaussian' , 't' , 'Clayton' , 'Frank' , 'Gumbel'
p	number of non-centrality parameters to be estimated (p = 0,1,2)
InitialValues	initial values c(a1,a2,tau) to start the estimation; otherwise pre-selected values will be used

Value

theta	Estimated parameter of the copula according to CRAN copula package
dof	Estimated degrees of freedom, only for the Student copula
tau	Estimated theoretical Kendall tau for the copula family

Author(s)

Bouchra R. Nasri, August 14, 2019

References

Section 5.1 of Nasri, Rémillard & Bouezmarni (2019). Semi-parametric copula-based models under non-stationarity, Journal of Multivariate Analysis, 173, pages 347-365.

Examples

```
param <- c(0.8, 2.5, 0.7) ;
U <- SimNCSCop('Clayton', 250, param)
estimation <- EstNCSCop(U,'Clayton')
```

---

initialValues *Initial values for estimation*

Description

This function computes initial values of non-centrality parameters and Kendall's tau at selected points for the estimation non-central squared copula parameters. The results are not satisfactory. Do not use.

Usage

```
initialValues(U, family = "Clayton")
```

Arguments

U	(nx2) data matrix of pseudo-observations.
family	'Gaussian' , 't' , 'Clayton' , 'Frank' , 'Gumbel'.

Value

paraml	Initial values for the non-centrality parameters and Kendall's tau to be included in the EstNCSCop function.

Author(s)

Bouchra R. Nasri, August 14, 2019

Examples

```
param <- c(0.8, 2.5, 0.7) ;
U <- SimNCSCop('Clayton', 250, param)
param = initialValues(U, 'Clayton');
```

KendallTau *Kendall's tau of a copula*

Description

This function computes the Kendall's tau of a copula family for a given a unconstrainted parameter alpha.

Usage

```
KendallTau(family, alpha)
```

Arguments

family	"Gaussian" , "t" , "Clayton" , "Frank" , "Gumbel"
alpha	unconstrainted parameters of the copula family

Value

tau	estimated Kendall's tau
theta	estimated copula parameter (constrained)

Author(s)

Bouchra R. Nasri, August 14, 2019

Examples

```
KendallTau('Clayton',0)
```

LoglikNCSCop *Log-likelihood of a non-central squared copula*

Description

This function computes the log-likelihood vector of a non-central squared copula

Usage

```
LoglikNCSCop(alpha, U, family, p = 2)
```

Arguments

alpha	unconstrained non-centrality parameters a1, a2, and unconstrained copula parameters.
U	(nx2) data matrix of pseudo-observations.
family	'Gaussian' , 't' , 'Clayton' , 'Frank' , 'Gumbel'.
p	number of different non-centrality parameters (0,1,2 default).

Value

LL	Vector of log-likelihoods

Author(s)

Bouchra R. Nasri, August 14, 2019

Examples

```
alpha = c(log(0.2),log(5),log(2),log(12));
param = c(0.5,2.5,0.5);
data = SimNCSCop('Clayton', 250, param);
LL = LoglikNCSCop(alpha,data,'Clayton')
```

NCSCopCdf *Distribution function of a non-central squared copula*

Description

This function computes the distribution function a non-central squared copula

Usage

```
NCSCopCdf(u, family, param, dof = NULL)
```

Arguments

u	(nx2) data matrix of pseudo-observations.
family	'Gaussian' , 't' , 'Clayton' , 'Frank' , 'Gumbel'.
param	c(a1,a2,tau) where a1,a2 are the non-negative non-centrality
dof	degrees of freedom of the Student copula (if needed).

Value

cdf	Non-central squared copula evaluated at points u.

Author(s)

Bouchra R. Nasri, August 14, 2019

Examples

```
param = c(0.8,2.5,0.7);
u = matrix(c(0.2,0.6,0.3,0.5,0.7,0.9),ncol=2,byrow=TRUE);
cdf=NCSCopCdf(u,'Clayton',param);
```

ParamCop *Gives the parameters of the copula family*

Description

This function computes the parameter of the copula according to CRAN copula package where corresponding to the unconstrainted parameters alpha.

Usage

```
ParamCop(family, alpha)
```

Arguments

family	"Gaussian" , "t" , "Clayton" , "Frank" , "Gumbel"
alpha	unconstrainted parameters of the copula family

Value

theta	Bivariate vector of constrained copula family parameters

Author(s)

Bouchra R. Nasri, August 14, 2019

Examples

```
ParamCop('Clayton',0)
```

ParamTau *Unconstrained parameters*

Description

This function computes the unconstrainted parameter alpha for a given Kendall's tau

Usage

```
ParamTau(family, tau)
```

Arguments

family	'Gaussian' , 't' , 'Clayton' , 'Frank' , 'Gumbel'
tau	Kendall's tau of the copula family

Value

alpha	Unconstrainted parameter

Author(s)

Bouchra R. Nasri, August 14, 2019

Examples

```
ParamTau('Clayton',0.5)
```

SimNCSCop *Simulation of a bivariate non-central squared copula*

Description

This function simulates observations a bivariate non-central squared copula model.

Usage

```
SimNCSCop(family, n, param, DoF = NULL)
```

Arguments

family	'Gaussian' , 't' , 'Clayton' , 'Frank' , 'Gumbel'.
n	number of simulated vectors.
param	c(a1,a2,tau) where a1,a2 are the non-negative non-centrality
DoF	degrees of freedom of the Student copula (if needed).

Value

U	Simulated Data

Author(s)

Bouchra R. Nasri, August 14, 2019

Examples

```
param <- c(0.8, 2.5, 0.7) ;
U <- SimNCSCop('Clayton', 250, param)
```

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