

# Package ‘CopulaGAMM’

January 20, 2025

**Type** Package

**Title** Copula-Based Mixed Regression Models

**Version** 0.4.1

**Description** Estimation of 2-level factor copula-based regression models for clustered data where the response variable can be either discrete or continuous.

**Depends** R (>= 3.5.0), stats, statmod, matrixStats

**License** GPL (>= 2)

**Encoding** UTF-8

**RoxygenNote** 7.2.3

**NeedsCompilation** yes

**Author** Pavel Krupskii [aut, ctb, cph],  
Bouchra R. Nasri [aut, ctb, cph],  
Bruno N Remillard [aut, cre, cph]

**Maintainer** Bruno N Remillard <bruno.remillard@hec.ca>

**Repository** CRAN

**Date/Publication** 2023-11-30 14:00:02 UTC

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*berncpdf*                      *Bernoulli with  $p = 1/(1+\exp(-th))$  cdf/pdf and derivatives*

---

### Description

This function computes the cdf, pdf, and associated derivatives

### Usage

```
berncpdf(z, th)
```

### Arguments

<code>z</code>	vector of responses
<code>th</code>	linear combination of covariates (can be negative)

### Value

`out`                      Matrix of conditional cdf and pdf with derivative with respect to parameters

### Author(s)

Pavel Krupskii and Bruno N. Remillard, January 20, 2022

### Examples

```
out = berncpdf(0, 2.5)
```

---

coplik *Copula cdf/pdf and ders*

---

### Description

Derivatives  $C(u|v)$ ,  $C'_{dl}(u|v)$ ,  $c(u,v)$ ,  $c'_{dl}(u,v)$ ,  $c'_u(u,v)$  for the linking copula

### Usage

```
coplik(u, v, family, rot = 0, cpar, dfC = NULL, du = FALSE)
```

### Arguments

u	vector of values in (0,1)
v	conditioning variable in (0,1)
family	copula family: "gaussian", "t", "clayton", "frank", "fgm", "gumbel", "joe", "plackett".
rot	rotation: 0 (default), 90, 180 (survival), or 270
cpar	copula parameter
dfC	degrees of freedom for the Student copula (default is NULL)
du	logical value (default = FALSE) for the derivative of the copula density with respect to u

### Value

out Matrix of conditional cdf, pdf, and derivatives with respect to parameters

### Author(s)

Pavel Krupskii and Bruno N. Remillard, January 20, 2022

### Examples

```
out = coplik(0.3, 0.5, "clayton", cpar=2, du=TRUE)
```

---

dbvn	<i>Normal density</i>
------	-----------------------

---

**Description**

Density at (x1,x2)

**Usage**

```
dbvn(x1, x2, rh)
```

**Arguments**

x1	vector of values
x2	vector of values
rh	correlation parameter, $-1 < rh < 1$

**Value**

out	Vector of densities
-----	---------------------

**Author(s)**

Pavel Krupskii

**Examples**

```
out = dbvn(0.3,0.5,-0.6)
```

---

dbvn2	<i>Normal density (version 2)</i>
-------	-----------------------------------

---

**Description**

Density at (x1,x2)

**Usage**

```
dbvn2(x1, x2, rh)
```

**Arguments**

x1	vector of values
x2	vector of values
rh	correlation parameter, $-1 < rh < 1$

**Value**

out                    Vector of densities

**Author(s)**

Pavel Krupskii

**Examples**

```
out = dbvn2(0.3,0.5,-0.4)
```

---

dbvncop

*Normal copula density*

---

**Description**

Density at (u,v)

**Usage**

```
dbvncop(u, v, cpar)
```

**Arguments**

u                    vector of values in (0,1)  
v                    vector of values in (0,1)  
cpar                 copula parameter,  $-1 < \text{cpar} < 1$

**Value**

out                    Vector of densities

**Author(s)**

Pavel Krupskii

**Examples**

```
out = dbvncop(0.3,0.5,-0.5)
```

---

dbvtcop	<i>Student copula density</i>
---------	-------------------------------

---

**Description**

Density at (u,v)

**Usage**

```
dbvtcop(u, v, cpar, dfC)
```

**Arguments**

u	vector of values in (0,1)
v	vector of values in (0,1)
cpar	copula parameter, $-1 < \text{cpar} < 1$
dfC	degrees of freedom

**Value**

out	Vector of densities
-----	---------------------

**Author(s)**

Pavel Krupskii

**Examples**

```
out = dbvtcop(0.3, 0.5, -0.7, 25)
```

---

dcop	<i>Copula pdf</i>
------	-------------------

---

**Description**

Evaluates the copula density at given points (u,v)#'

**Usage**

```
dcop(u, v, family, rot = 0, cpar, dfC = NULL)
```

**Arguments**

u	vector of values in (0,1)
v	conditioning variable in (0,1)
family	copula family: "gaussian" ("normal"), "t", "clayton", "frank", "fgm", "galambos", "gumbel", "joe", "huesler-reiss", "plackett".
rot	rotation: 0 (default), 90, 180 (survival), or 270
cpar	copula parameter
dfc	degrees of freedom for the Student copula (default is NULL)

**Value**

out	Copula density
out	Vector of pdf values

**Author(s)**

Pavel Krupskii and Bruno Remillard Mai 1, 2023

**Examples**

```
out = dcop(0.3, 0.7, "clayton", 270, 2)
```

---

dfgm

*Farlie-Gumbel-Morgenstern copula density,  $-1 \leq cpar \leq 1$* 


---

**Description**

Density at (u,v)

**Usage**

```
dfgm(u, v, cpar)
```

**Arguments**

u	vector of values in (0,1)
v	vector of values in (0,1)
cpar	copula parameter $> 0$

**Value**

out	Vector of densities
-----	---------------------

**Author(s)**

Pavel Krupskii



**Examples**

```
out = dfgm(0.3,0.5,0.2)
```

---

dfrk	<i>B3 bivariate Frank copula density</i>
------	--

---

**Description**

Density at (u,v)

**Usage**

```
dfrk(u, v, cpar)
```

**Arguments**

u	vector of values in (0,1)
v	vector of values in (0,1)
cpar	copula parameter, cpar>0 or cpar<0

**Value**

out	Vector of densities
-----	---------------------

**Author(s)**

Pavel Krupskii

**Examples**

```
out = dfrk(0.3,0.5,2)
```

---

dgal	<i>B7 Galambos copula density, cpar&gt;0</i>
------	--

---

**Description**

Density at (u,v)

**Usage**

```
dgal(u, v, cpar)
```

**Arguments**

u                    vector of values in (0,1)  
v                    vector of values in (0,1)  
cpar                copula parameter > 0

**Value**

out                Vector of densities

**Author(s)**

Pavel Krupskii

**Examples**

```
out = dgum(0.3, 0.5, 2)
```

---

dgum

*B6 Gumbel copula density, cpar > 1*

---

**Description**

Density at (u,v)

**Usage**

```
dgum(u, v, cpar)
```

**Arguments**

u                    vector of values in (0,1)  
v                    vector of values in (0,1)  
cpar                copula parameter > 0

**Value**

out                Vector of densities

**Author(s)**

Pavel Krupskii

**Examples**

```
out = dgum(0.3, 0.5, 2)
```

---

dhr *B8 Huesler-Reiss copula density, cpar>0*

---

**Description**

Density at (u,v)

**Usage**

dhr(u, v, cpar)

**Arguments**

u                    vector of values in (0,1)  
v                    vector of values in (0,1)  
cpar                copula parameter > 0

**Value**

out                 Vector of densities

**Author(s)**

Pavel Krupskii

**Examples**

```
out = dhr(0.3,0.5,2)
```

---

djoe *B5 Joe copula density*

---

**Description**

Density at (u,v)

**Usage**

djoe(u, v, cpar)

**Arguments**

u                    vector of values in (0,1)  
v                    vector of values in (0,1)  
cpar                copula parameter > 1

**Value**

out                    Vector of densities

**Author(s)**

Pavel Krupskii

**Examples**

```
out = djoe(0.3,0.5,2)
```

---

dmtcj

*B4 MTCJ copula density, cpar>0*

---

**Description**

Density at (u,v)

**Usage**

```
dmtcj(u, v, cpar)
```

**Arguments**

u                    vector of values in (0,1)  
v                    vector of values in (0,1)  
cpar                copula parameter > 0

**Value**

out                    Vector of densities

**Author(s)**

Pavel Krupskii

**Examples**

```
out = dmtcj(0.3,0.5,2)
```

---

dpla	<i>B2 Plackett copula density</i>
------	-----------------------------------

---

**Description**

Density at (u,v)

**Usage**

```
dpla(u, v, cpar)
```

**Arguments**

u	vector of values in (0,1)
v	vector of values in (0,1)
cpar	copula parameter > 0

**Value**

out	Vector of densities
-----	---------------------

**Author(s)**

Pavel Krupskii

**Examples**

```
out = dpla(0.3,0.5,2)
```

---

EstContinuous	<i>Copula-based estimation of mixed regression models for continuous response</i>
---------------	---

---

**Description**

This function computes the estimation of a copula-based 2-level hierarchical model.

**Usage**

```
EstContinuous(
  y,
  model,
  family,
  rot = 0,
  clu,
  xc = NULL,
  xm = NULL,
  start,
  LB,
  UB,
  nq = 31,
  dfM = NULL,
  dfC = NULL,
  prediction = TRUE
)
```

**Arguments**

y	n x 1 vector of response variable (assumed continuous).
model	function for margins: "gaussian" (normal), "t" (Student with known df=dfM), "laplace", "exponential", "weibull".
family	copula family: "gaussian", "t", "clayton", "frank", "fgm", "gumbel".
rot	rotation: 0 (default), 90, 180 (survival), or 270
clu	variable of size n defining the clusters; can be a factor
xc	covariates of size n for the estimation of the copula, in addition to the constant; default is NULL.
xm	covariates of size n for the estimation of the mean of the margin, in addition to the constant; default is NULL.
start	starting point for the estimation; could be the ones associated with a Gaussian-copula model defined by lmer.
LB	lower bound for the parameters.
UB	upper bound for the parameters.
nq	number of nodes and weighted for Gaussian quadrature of the product of conditional copulas; default is 25.
dfM	degrees of freedom for a Student margin; default is 0 for non-t distribution,
dfC	degrees of freedom for a Student margin; default is 5.
prediction	logical variable for prediction of latent variables V; default is TRUE.

**Value**

coefficients	Estimated parameters
sd	Standard deviations of the estimated parameters

tstat	T statistics for the estimated parameters
pval	P-values of the t statistics for the estimated parameters
gradient	Gradient of the log-likelihood
loglik	Log-likelihood
aic	AIC coefficient
bic	BIC coefficient
cov	Covariance matrix of the estimations
grd	Gradients by clusters
clu	Cluster values
Matxc	Matrix of covariates defining the copula parameters, including a constant
Matxm	Matrix of covariates defining the margin parameters, including a constant
V	Estimated value of the latent variable by clusters (if prediction=TRUE)
cluster	Unique values of clusters
family	Copula family
tau	Kendall's tau by observation
thC0	Estimated parameters of the copula by observation
thF	Estimated parameters of the margins by observation
pcond	Conditional copula cdf
fcpdf	Margin functions (cdf and pdf)
dfM	Degrees of freedom for Student margin (default is NULL)
dfC	Degrees of freedom for the Student copula (default is NULL)

### Author(s)

Pavel Krupskii, Bouchra R. Nasri and Bruno N. Remillard

### References

Krupskii, Nasri & Remillard (2023). On factor copula-based mixed regression models

### Examples

```
data(normal) #simulated data with normal margins
start=c(0,0,0,1); LB=c(rep(-10,3),0.001);UB=c(rep(10,3),10)
y=normal$y; clu=normal$clu; xm=normal$xm
out=EstContinuous(y,model="gaussian",family="clayton",rot=90,clu=clu,xm=xm,start=start,LB=LB,UB=UB)
```

---

EstDiscrete	<i>Copula-based estimation of mixed regression models for discrete response</i>
-------------	---

---

### Description

This function computes the estimation of a copula-based 2-level hierarchical model.

### Usage

```
EstDiscrete(
  y,
  model,
  family,
  rot = 0,
  clu,
  xc = NULL,
  xm = NULL,
  start,
  LB,
  UB,
  nq = 25,
  dfC = NULL,
  offset = NULL,
  prediction = TRUE
)
```

### Arguments

y	n x 1 vector of response variable (assumed continuous).
model	margins: "binomial" or "bernoulli", "poisson", "nbinom" (Negative Binomial), "geometric", "multinomial".
family	copula family: "gaussian", "t", "clayton", "frank", "fgm", "gumbel".
rot	rotation: 0 (default), 90, 180 (survival), or 270
clu	variable of size n defining the clusters; can be a factor
xc	covariates of size n for the estimation of the copula, in addition to the constant; default is NULL.
xm	covariates of size n for the estimation of the mean of the margin, in addition to the constant; default is NULL.
start	starting point for the estimation; could be the ones associated with a Gaussian-copula model defined by lmer.
LB	lower bound for the parameters.
UB	upper bound for the parameters.



nq	number of nodes and weighted for Gaussian quadrature of the product of conditional copulas; default is 25.
dfC	degrees of freedom for a Student margin; default is 0.
offset	offset (default is NULL)
prediction	logical variable for prediction of latent variables V (default is TRUE).

**Value**

coefficients	Estimated parameters
sd	Standard deviations of the estimated parameters
tstat	T statistics for the estimated parameters
pval	P-values of the t statistics for the estimated parameters
gradient	Gradient of the log-likelihood
loglik	Log-likelihood
aic	AIC coefficient
bic	BIC coefficient
cov	Covariance matrix of the estimations
grd	Gradients by clusters
clu	Cluster values
Matxc	Matrix of covariates defining the copula parameters, including a constant
Matxm	Matrix of covariates defining the margin parameters, including a constant
V	Estimated value of the latent variable by clusters (if prediction=TRUE)
cluster	Unique clusters
family	Copula family
thC0	Estimated parameters of the copula by observation
thF	Estimated parameters of the margins by observation
rot	rotation
dfC	Degrees of freedom for the Student copula
model	Name of the margins
disc	Discrete margin number

**Author(s)**

Pavel Krupskii, Bouchra R. Nasri and Bruno N. Remillard

**References**

Krupskii, Nasri & Remillard (2023). On factor copula-based mixed regression models

**Examples**

```

data(sim.poisson) #simulated data with Poisson margins
start=c(2,8,3,-1); LB = c(-3, 3, -7, -6);UB=c( 7, 13, 13, 4)
y=sim.poisson$y; clu=sim.poisson$clu;
xc=sim.poisson$xc; xm=sim.poisson$xm
model = "poisson"; family="frank"
out.poisson=EstDiscrete(y,model,family,rot=0,clu,xc,xm,start,UB,nq=31,prediction=TRUE)

```

expcnd

*Conditional expectation***Description**

This function computes the conditional expectation for a given copula family and a given margin variables for a clustered data model. The clusters are independent but the observations within clusters are dependent, according to a one-factor copula model.

**Usage**

```
expcnd(w, family, rot = 0, cpar, margin, dfC = NULL, subs = 1000)
```

**Arguments**

w	value of the conditioning random variable
family	copula model: "gaussian", "t", "clayton", "joe", "frank", "gumbel", "plackett"
rot	rotation: 0 (default), 90, 180 (survival), or 270
cpar	copula parameter
margin	marginal distribution function
dfC	degrees of freedom for the Student copula (default is NULL)
subs	number of subdivisions for the integrals (default=1000)

**Value**

mest	Conditional expectations
------	--------------------------

**Author(s)**

Pavel Krupskii and Bruno N. Remillard

**Examples**

```

margin = function(x){ppois(x,10)}
expcnd(0.4, 'clayton', cpar=2, margin=margin)

```

---

expcndinv                      *Inverse conditional expectation for a vector of probabilities*

---

### Description

This function computes the inverse conditional expectation for a given copula family and a given margin variables for a clustered data model. The clusters are independent but the observations with clusters are dependent, according to a one-factor copula model.

### Usage

```
expcndinv(u, family, cpar, rot = 0, margin, subs = 1000, eps = 1e-04)
```

### Arguments

u	conditional expectation
family	copula model: "gaussian" , "t" , "clayton" "joe", "frank" , "gumbel", "plackett"
cpar	copula parameter
rot	rotation: 0 (default), 90, 180 (survival), or 270
margin	marginal distribution function of the response
subs	number of subdivisions for the integrals (default=1000)
eps	precision required

### Value

minv	Inverse conditional expectation
------	---------------------------------

### Author(s)

Pavel Krupskii and Bruno N. Remillard

---

expcndinv1                      *Inverse conditional expectation for a single value*

---

### Description

Inverse conditional expectation for a single value

### Usage

```
expcndinv1(u, family, cpar, rot = 0, margin, subs = 1000, eps = 1e-04)
```

**Arguments**

u	conditional expectation
family	copula model: "gaussian" , "t" , "clayton" "joe", "frank" , "gumbel", "plackett"
cpar	copula parameter
rot	rotation: 0 (default), 90, 180 (survival), or 270
margin	marginal distribution function of the response
subs	number of subdivisions for the integrals (default=1000)
eps	precision required

**Value**

minv	Inverse conditional expectation
------	---------------------------------

---

expcpdf	<i>Exponential cdf/pdf and ders</i>
---------	-------------------------------------

---

**Description**

This function computes the cdf, pdf, and associated derivatives

**Usage**

```
expcpdf(z, th)
```

**Arguments**

z	vector of responses
th	th is rate > 0

**Value**

out Matrix of conditional cdf, derivative with respect to parameter, pdf,

**Author(s)**

Pavel Krupskii and Bruno N. Remillard, January 20, 2022

**Examples**

```
out = expcpdf(2,3)
```

---

ffgmders *Farlie-Gumbel-Morgenstern copula cdf/pdf and ders*

---

### Description

Derivatives  $C(u|v)$ ,  $C'_{dl}(u|v)$ ,  $c(u,v)$ ,  $c'_{dl}(u,v)$ ,  $c'_u(u,v)$  for the linking copula

### Usage

```
ffgmders(u, v, cpar, du = FALSE)
```

### Arguments

u	vector of values in (0,1)
v	conditioning variable in (0,1)
cpar	copula parameter in [-1,1]
du	logical value (default = FALSE) for the derivative of the copula density with respect to u

### Value

out	Matrix of conditional cdf, pdf, and derivatives with respect to parameter
-----	---

### Author(s)

Pavel Krupskii and Bruno N. Remillard, January 20, 2022

### Examples

```
out = ffgmders(0.3, 0.5, 2, TRUE)
```

---

ffrkders *Frank copula cdf/pdf and ders*

---

### Description

Derivatives  $C(u|v)$ ,  $C'_{dl}(u|v)$ ,  $c(u,v)$ ,  $c'_{dl}(u,v)$ ,  $c'_u(u,v)$  for the linking copula

### Usage

```
ffrkders(u, v, cpar, du = FALSE)
```

**Arguments**

u	vector of values in (0,1)
v	conditioning variable in (0,1)
cpar	copula parameter
du	logical value (default = FALSE) for the derivative of the copula density with respect to u

**Value**

out	Matrix of conditional cdf, pdf, and derivatives with respect to parameter
-----	---

**Author(s)**

Pavel Krupskii and Bruno N. Remillard, January 20, 2022

**Examples**

```
out = ffrkders(0.3, 0.5, 2, TRUE)
```

---

fgumders

*Gumbel copula cdf/pdf and ders*


---

**Description**

Derivatives  $C(u|v)$ ,  $C'_{dl}(u|v)$ ,  $c(u,v)$ ,  $c'_{dl}(u,v)$ ,  $c'_u(u,v)$  for the linking copula

**Usage**

```
fgumders(u, v, cpar, du = FALSE)
```

**Arguments**

u	vector of values in (0,1)
v	conditioning variable in (0,1)
cpar	copula parameter > 1
du	logical value (default = FALSE) for the derivative of the copula density with respect to u

**Value**

out	Matrix of conditional cdf, pdf, and derivatives with respect to parameter
-----	---

**Author(s)**

Pavel Krupskii and Bruno N. Remillard, January 20, 2022

**Examples**

```
out = fgumders(0.3,0.5,2,TRUE)
```

---

fjoeders

*Joe copula cdf/pdf and ders*

---

**Description**

Derivatives  $C(u|v)$ ,  $C'_{dl}(u|v)$ ,  $c(u,v)$ ,  $c'_{dl}(u,v)$ ,  $c'_u(u,v)$  for the linking copula

**Usage**

```
fjoeders(u, v, cpar, du = FALSE)
```

**Arguments**

u	vector of values in (0,1)
v	conditioning variable in (0,1)
cpar	copula parameter > 1
du	logical value (default = FALSE) for the derivative of the copula density with respect to u

**Value**

out Matrix of conditional cdf, pdf, and derivatives with respect to parameter

**Author(s)**

Pavel Krupskii and Bruno N. Remillard, January 20, 2022

**Examples**

```
out = fjoeders(0.3,0.5,2,TRUE)
```

---

 fmtcjders

*Clayton copula cdf/pdf and ders*


---

**Description**

Derivatives  $C(u|v)$ ,  $C'_{dl}(u|v)$ ,  $c(u,v)$ ,  $c'_{dl}(u,v)$ ,  $c'_u(u,v)$  for the linking copula

**Usage**

```
fmtcjders(u, v, cpar, du = FALSE)
```

**Arguments**

u	vector of values in (0,1)
v	conditioning variable in (0,1)
cpar	copula parameter > 0
du	logical value (default = FALSE) for the derivative of the copula density with respect to u

**Value**

out	Matrix of conditional cdf, pdf, and derivatives with respect to parameter
-----	---

**Author(s)**

Pavel Krupskii and Bruno N. Remillard, January 20, 2022

**Examples**

```
out = fmcjders(0.3,0.5,2,TRUE)
```

---

 fnorders

*Farlie-Gumbel-Morgenstern copula cdf/pdf and ders*


---

**Description**

Derivatives  $C(u|v)$ ,  $C'_{dl}(u|v)$ ,  $c(u,v)$ ,  $c'_{dl}(u,v)$ ,  $c'_u(u,v)$  for the linking copula

**Usage**

```
fnorders(u, v, cpar, du = FALSE)
```



**Arguments**

u	vector of values in (0,1)
v	conditioning variable in (0,1)
cpar	copula parameter in (-1,1)
du	logical value (default = FALSE) for the derivative of the copula density with respect to u

**Value**

out	Matrix of conditional cdf, pdf, and derivatives with respect to parameter
-----	---

**Author(s)**

Pavel Krupskii and Bruno N. Remillard, January 20, 2022

**Examples**

```
out = fnorders(0.3, 0.5, 0.6, TRUE)
```

---

fpladers

*Plackett copula cdf/pdf and ders*

---

**Description**

Derivatives  $C(u|v)$ ,  $C'_{dl}(u|v)$ ,  $c(u,v)$ ,  $c'_{dl}(u,v)$ ,  $c'_u(u,v)$  for the linking copula

**Usage**

```
fpladers(u, v, cpar, du = FALSE)
```

**Arguments**

u	vector of values in (0,1)
v	conditioning variable in (0,1)
cpar	copula parameter $> 0$
du	logical value (default = FALSE) for the derivative of the copula density with respect to u

**Value**

out	Matrix of conditional cdf, pdf, and derivatives with respect to parameter
-----	---

**Author(s)**

Pavel Krupskii and Bruno N. Remillard, January 20, 2022

**Examples**

```
out = fpladers(0.3,0.5,2,TRUE)
```

---

ftders

*Student copula cdf/pdf and ders*


---

**Description**

Derivatives  $C(u|v)$ ,  $C'_{dl}(u|v)$ ,  $c(u,v)$ ,  $c'_{dl}(u,v)$ ,  $c'_u(u,v)$  for the linking copula

**Usage**

```
ftders(u, v, cpar, nu, du = FALSE)
```

**Arguments**

u	vector of values in (0,1)
v	conditioning variable in (0,1)
cpar	copula parameter in (-1,1)
nu	degrees of freedom >0
du	logical value (default = FALSE) for the derivative of the copula density with respect to u

**Value**

out                    Matrix of conditional cdf, pdf, and derivatives with respect to parameter

**Author(s)**

Pavel Krupskii and Bruno N. Remillard, January 20, 2022

**Examples**

```
out = ftders(0.3,0.5,2,25)
```

---

ftdersP *Student copula cdf/pdf and ders*

---

**Description**

Derivatives  $C(u|v)$ ,  $C'_{dl}(u|v)$ ,  $c(u,v)$ ,  $c'_{dl}(u,v)$ ,  $c'_u(u,v)$  for the linking copula

**Usage**

```
ftdersP(u, v, cpar, dfC, du = FALSE)
```

**Arguments**

**u** vector of values in (0,1)  
**v** conditioning variable in (0,1)  
**cpar** copula parameter in (-1,1)  
**dfC** degrees of freedom  
**du** logical value (default = FALSE) for the derivative of the copula density with respect to u

**Value**

**out** Matrix of conditional cdf, pdf, and derivatives with respect to parameter

**Author(s)**

Pavel Krupskii and Bruno N. Remillard, January 20, 2022

**Examples**

```
out = ftdersP(0.3, 0.5, 2, 25, TRUE)
```

---

geomcpdf *Geometric with  $p = 1/(1+\exp(-th))$  cdf/pdf and ders*

---

**Description**

This function computes the cdf, pdf, and associated derivatives

**Usage**

```
geomcpdf(z, th)
```

**Arguments**

z                    vector of responses  
th                   linear combination of covariates (can be negative)

**Value**

out                   Matrix of conditional cdf, derivative with respect to parameter, pdf,

**Author(s)**

Pavel Krupskii and Bruno N. Remillard, January 20, 2022

**Examples**

```
out = geomcpdf(0, -3)
```

---

invfunc                    *Inverse function*

---

**Description**

This function is used to get the inverse of a monotonic function on (0,1), depending on parameters, and using the bisection method

**Usage**

```
invfunc(q, func, th, lb = 1e-12, ub = 1 - 1e-12, tol = 1e-08, nbreak = 40)
```

**Arguments**

q                    Function value (can be a vector if func() supports a vector argument)  
func                   Function of one argument to be inverted  
th                    Function parameters  
lb                    Lower bound for the possible values  
ub                    Upper bound for the possible values  
tol                    Tolerance for the inversion  
nbreak                Maximum number of iterations (default is 40)

**Value**

out                   Inverse values

**Author(s)**

Pavel Krupskii

---

lapcpdf	<i>Laplace cdf/pdf and ders</i>
---------	---------------------------------

---

**Description**

This function computes the cdf, pdf, and associated derivatives

**Usage**

```
lapcpdf(z, th)
```

**Arguments**

z	vector of responses
th	th[,1] is mean, th[,2] is standard deviation > 0

**Value**

out	Matrix of conditional cdf, derivative with respect to parameter, pdf,
-----	---

**Author(s)**

Pavel Krupskii and Bruno N. Remillard, January 20, 2022

**Examples**

```
out = lapcpdf(2, c(-3, 4))
```

---

linkCop	<i>Link to copula parameter</i>
---------	---------------------------------

---

**Description**

Computes the copula parameters given a linear combination of covariates.

**Usage**

```
linkCop(th, family = "clayton")
```

**Arguments**

th	vector of linear combinations
family	copula family: "gaussian", "t", "clayton", "claytonR", "frank", "gumbel", "gumbelR".

**Value**

cpar	Associated copula parameters
hder	Derivative of link function

**Author(s)**

Pavel Krupskii and Bruno N. Remillard, January 20, 2023

**References**

Krupskii, Nasri & Remillard (2023). On factor copula-based mixed regression models

**Examples**

```
out = linkCop(-1, "gaussian")
```

---

MAP.continuous

*Estimation of latent variables in the continuous case*

---

**Description**

This function computes the estimation of a latent variables for each cluster using the conditional a posteriori median.

**Usage**

```
MAP.continuous(u, family, rot, thC0k, dfC = NULL, nq = 35)
```

**Arguments**

u	vector of values in (0,1)
family	copula family: "gaussian" , "t" , "clayton" , "joe" , "frank" , "fgm", "gumbel", "plackett", "galambos", "huesler-reiss"
rot	rotation: 0 (default), 90, 180 (survival), or 270.
thC0k	vector of copula parameters
dfC	degrees of freedom for the Student copula (default is NULL)
nq	number of nodes and weighted for Gaussian quadrature of the product of conditional copulas; default is 31.

**Value**

condmed	Conditional a posteriori median.
---------	----------------------------------

**Author(s)**

Pavel Krupskii, Bouchra R. Nasri and Bruno N. Remillard

**References**

Krupskii, Nasri & Remillard (2023). On factor copula-based mixed regression models

**Examples**

```
u = c(0.5228155, 0.3064417, 0.2789849, 0.5176489, 0.3587144)
thC0k=rep(17.54873,5)
MAP.continuous(u,"clayton",rot=90,thC0k,nq=35)
```

---

MAP.discrete

*Estimation of latent variable in the discrete case*


---

**Description**

This function computes the estimation of a latent variables for each cluster using the conditional a posteriori median.

**Usage**

```
MAP.discrete(vv, uu, family, rot, thC0k, dfc = NULL, nq = 35)
```

**Arguments**

vv	vector of values in (0,1)
uu	vector of values in (0,1)
family	copula family "gaussian" , "t" , "clayton" , "joe", "frank" , "fgm", "gumbel", "plackett", "galambos", "huesler-reiss"
rot	rotation: 0 (default), 90, 180 (survival), or 270.
thC0k	vector of copula parameters
dfc	degrees of freedom for the Student copula (default is NULL)
nq	number of nodes and weighted for Gaussian quadrature of the product of conditional copulas; default is 31.

**Value**

condmed	Conditional a posteriori median.
---------	----------------------------------

**Author(s)**

Pavel Krupskii, Bouchra R. Nasri and Bruno N. Remillard

**References**

Krupskii, Nasri & Remillard (2023). On factor copula-based mixed regression models

**Examples**

```
uu = c(0.5228155, 0.3064417, 0.2789849, 0.5176489, 0.3587144)
vv = c(0.7816627, 0.6688788, 0.6351364, 0.7774917, 0.7264787)
thC0k=rep(17.54873,5)
MAP.discrete(vv,uu,"clayton",rot=90,thC0k,nq=35)
```

---

margins

---

*Margins cdf/pdf and their derivatives*


---

**Description**

This function computes the cdf, pdf, and associated derivatives

**Usage**

```
margins(z, th, model, x = NULL, dfM = NULL)
```

**Arguments**

z	vector of responses
th	linear combination of covariates (can be negative)
model	model for margin: "binomial" (bernoulli), "poisson", "nbinom" (mean is the parameter), "nbinom1" (p is the parameter), "geometric", "multinomial", "exponential", "weibull", "normal", "t", "laplace"
x	covariates for the multinomial margin (default is NULL)
dfM	degrees of freedom for the Student margin (default is NULL)

**Value**

out	Matrix of conditional cdf, derivative with respect to parameter, pdf,
-----	---

**Author(s)**

Pavel Krupskii and Bruno N. Remillard, January 20, 2022

**Examples**

```
out = margins(0,2.5,"binomial")
```



---

mlecop	<i>Estimation of the parameter of a bivariate copula (Clayton, Frank, Gumbel)</i>
--------	---

---

### Description

Computes the MLE estimation for a bivariate copula using gradient. The likelihood is likelihood is  $c(u,v;\theta)$

### Usage

```
mlecop(u, v, fcopders, start = 2, LB = 1.01, UB = 7)
```

### Arguments

u	vector of values in (0,1)
v	vector of values in (0,1)
fcopders	ffrkders, fgumders or fmtcjders
start	starting value for the parameter (default =2)
LB	lower bound for the parameter (default is 1.01)
UB	upper bound for the parameter (default is 7)

### Value

mle	List of outputs from nlm function
-----	-----------------------------------

### Author(s)

Pavel Krupskii

### Examples

```
set.seed(2)
v = runif(250)
w = runif(250)
u = 1/sqrt(1+(w^(-2/3)-1)/v^2) # Clayton copula with parameter 2 (tau=0.5)
out = mlecop(u,v,fmtcjders)
```

---

mlecop.disc	<i>Estimation of the parameter of a bivariate copula (Clayton, Frank, Gumbel) when the first observation is 0 or 1</i>
-------------	--

---

### Description

Computes the MLE estimation for a bivariate copula using gradient. The likelihood is likelihood is  $C(1-p|v;\theta)$  if  $y=0$  and  $1-C(1-p|v;\theta)$  if  $y=1$

### Usage

```
mlecop.disc(y, v, fcopders, start = 2, LB = 1.01, UB = 7)
```

### Arguments

y	vector of binary values 0 or 1
v	vector of values in (0,1)
fcopders	ffrkders, fgumders or fmtcjdgers
start	starting value for the parameter (default =2)
LB	lower bound for the parameter (default is 1.01)
UB	upper bound for the parameter (default is 7)

### Value

mle	List of outputs from nlm function
-----	-----------------------------------

### Author(s)

Pavel Krupskii

### Examples

```
set.seed(2)
v = runif(250)
w = runif(250)
u = 1/sqrt(1+(w^(-2/3)-1)/v^2) #Clayton with parameter 2
y = as.numeric(u>0.6) # if one takes (u<4), one obtains a rotation of the Clayton!
out = mlecop.disc(y,v,fmtcjdgers)
```

---

multinomcpdf	<i>Multinomial with <math>p = 1/(1+\exp(-th))</math> cdf/pdf and ders</i>
--------------	---

---

**Description**

This function computes the cdf, pdf, and associated derivatives

**Usage**

```
multinomcpdf(z, th, x)
```

**Arguments**

z	vector of responses taking values in 1,...,nL: as.number(z) if z is a factor!
th	th is a n x (L-1) matrix of parameters, i.e., mpar = a=[a_1,1,...a_1,k2,a_2,1,...a_2,k2,...a_{L-1},1... a_{L-1},k2], and first level is the baseline.
x	matrix of covariates (including the constant)

**Value**

out	Matrix of conditional cdf, derivative with respect to parameter, pdf,
-----	---

**Author(s)**

Pavel Krupskii and Bruno N. Remillard, January 20, 2022

**Examples**

```
x=matrix(c(1,1,-1,-1,0,2),nrow=2)
z = c(1,3)
th = matrix(c(1,2,3,4,5,6),nrow=2)
out = multinomcpdf(z,th,x = x)
```

---

multinomial	<i>Simulated data</i>
-------------	-----------------------

---

**Description**

Simulated clustered data from a Clayton copula with parameter 2, and multinomial margins with 3 levels and parameters 1.0,-1 for level 2 and 0.5, 2 for level 3. Clusters and covariates are included.

**Usage**

```
data(multinomial)
```

**Format**

Data frame of numerical values

**Examples**

```
data(multinomial)
```

---

nbinom1cpdf	<i>Negative binomial cdf/pdf and ders</i>
-------------	---

---

**Description**

This function computes the cdf, pdf, and associated derivatives

**Usage**

```
nbinom1cpdf(z, th)
```

**Arguments**

z	vector of responses
th	th[,1] is size > 0 and th[,2] is mean > 0; size does not have to be integer

**Value**

out	Matrix of conditional cdf, derivative with respect to parameter, pdf,
-----	---

**Author(s)**

Pavel Krupskii and Bruno N. Remillard, January 20, 2022

**Examples**

```
out = nbinom1cpdf(0, c(1, 0.5))
```

---

nbinomcpdf	<i>Negative binomial cdf/pdf and ders</i>
------------	---

---

**Description**

This function computes the cdf, pdf, and associated derivatives

**Usage**

```
nbinomcpdf(z, th)
```

**Arguments**

z	vector of responses
th	th[,1] is size > 0 and th[,2] is p, with $0 < p < 1$ ; size does not have to be integer

**Value**

out	Matrix of conditional cdf, derivative with respect to parameter, pdf,
-----	---

**Author(s)**

Pavel Krupskii and Bruno N. Remillard, January 20, 2022

**Examples**

```
out = nbinomcpdf(0, c(1, 0.5))
```

---

normal	<i>Simulated data</i>
--------	-----------------------

---

**Description**

Simulated clustered data from a Clayton copula with parameter 2, rotation = 90, and normal margins with 1,-1 for the mean, and sd = 4. Clusters and covariates are included.

**Usage**

```
data(normal)
```

**Format**

List of simulated values (y, clu, xm)

**Examples**

```
data(normal)
```

---

normcpdf	<i>normal cdf/pdf and ders</i>
----------	--------------------------------

---

**Description**

This function computes the cdf, pdf, and associated derivatives

**Usage**

```
normcpdf(z, th)
```

**Arguments**

z	vector of responses
th	th[,1] is mean, th[,2] is standard deviation > 0;

**Value**

out	Matrix of conditional cdf, derivative with respect to parameter, pdf,
-----	---

**Author(s)**

Pavel Krupskii and Bruno N. Remillard, January 20, 2022

**Examples**

```
out = normcpdf(2,c(-3,4))
```

---

out.normal	<i>EstContinuous object</i>
------------	-----------------------------

---

**Description**

Output of EstContinuous for the simulated clustered data normal.

**Usage**

```
data(out.normal)
```

**Format**

Data frame of numerical values

**Examples**

```
data(out.normal)
```

---

out.poisson	<i>EstDiscrete object</i>
-------------	---------------------------

---

**Description**

Output of EstDiscrete for the simulated clustered data poisson.

**Usage**

```
data(out.poisson)
```

**Format**

Data frame of numerical values

**Examples**

```
data(out.poisson)
```

---

pcond	<i>Conditional cdf</i>
-------	------------------------

---

**Description**

This function computes the conditional cdf  $C(U|V)$  for a copula  $C$

**Usage**

```
pcond(U, V, family, rot = 0, cpar, dfC = NULL)
```

**Arguments**

U	values at which the cdf is evaluated
V	value of the conditioning variable in (0,1)
family	"gaussian", "t", "clayton", "joe", "frank", "fgm", "gumbel", "plackett", "galambos", "huesler-reiss"
rot	rotation: 0 (default), 90, 180 (survival), or 270
cpar	copula parameter (vector)
dfC	degrees of freedom of the Student copula (default is NULL)

**Value**

p	Conditional cdf
---	-----------------

**Author(s)**

Pavel Krupskii and Bruno N. Remillard, January 20, 2022

**Examples**

```
p = pcond(0.1, 0.2, "clayton", rot=270, cpar=0.87)
```

---

pcondcla	<i>Conditional Clayton</i>
----------	----------------------------

---

**Description**

Conditional Clayton

**Usage**

```
pcondcla(u, v, cpar)
```

**Arguments**

u	values at which the cdf is evaluated
v	value of the conditioning variable in (0,1)
cpar	copula parameter

**Value**

ccdf	Conditional cdf
------	-----------------

**Examples**

```
pcondcla(0.5, 0.6, 2)
```

---

pcondfgm	<i>Conditional FGM (B10)</i>
----------	------------------------------

---

**Description**

Conditional FGM (B10)

**Usage**

```
pcondfgm(u, v, cpar)
```



**Arguments**

u                    probability  
v                    value of the conditioning variable in (0,1)  
cpar                copula parameter  $-1 \leq \text{cpar} \leq 1$

**Value**

ccdf                Conditional cdf

**Examples**

`pcondfgm(0.5, 0.6, 0.9)`

---

`pcondfrk`                    *Conditional Frank (B3)*

---

**Description**

Conditional Frank (B3)

**Usage**

`pcondfrk(u, v, cpar)`

**Arguments**

u                    values at which the cdf is evaluated  
v                    value of the conditioning variable in (0,1)  
cpar                copula parameter

**Value**

ccdf                Conditional cdf

**Examples**

`pcondfrk(0.5, 0.6, 2)`

---

pcondgal                      *Conditional Galambos (B7)*

---

**Description**

Conditional Galambos (B7)

**Usage**

pcondgal(u, v, cpar)

**Arguments**

u                      values at which the cdf is evaluated  
v                      value of the conditioning variable in (0,1)  
cpar                    copula parameter

**Value**

ccdf                    Conditional cdf

**Examples**

pcondgal(0.5, 0.6, 2)

---

pcondgum                      *Conditional Gumbel (B6)*

---

**Description**

Conditional Gumbel (B6)

**Usage**

pcondgum(u, v, cpar)

**Arguments**

u                      values at which the cdf is evaluated  
v                      value of the conditioning variable in (0,1)  
cpar                    copula parameter >1

**Value**

ccdf                    Conditional cdf

**Examples**

```
pcondgum(0.5, 0.6, 2)
```

---

pcondhr                      *Conditional Huesler-Reiss (B8)*

---

**Description**

Conditional Huesler-Reiss (B8)

**Usage**

```
pcondhr(u, v, cpar)
```

**Arguments**

u	values at which the cdf is evaluated
v	value of the conditioning variable in (0,1)
cpar	copula parameter >0

**Value**

ccdf	Conditional cdf
------	-----------------

**Examples**

```
pcondhr(0.5, 0.6, 2)
```

---

pcondjoe                      *Conditional Joe (B5)*

---

**Description**

Conditional Joe (B5)

**Usage**

```
pcondjoe(u, v, cpar)
```

**Arguments**

u	values at which the cdf is evaluated
v	value of the conditioning variable in (0,1)
cpar	copula parameter

**Value**

ccdf                    Conditional cdf

**Examples**

pcondjoe(0.5, 0.6, 2)

---

pcondnor                    *Conditional Gaussian*

---

**Description**

Conditional Gaussian

**Usage**

pcondnor(u, v, cpar)

**Arguments**

u                    values at which the cdf is evaluated  
v                    value of the conditioning variable in (0,1)  
cpar                copula parameter

**Value**

ccdf                    Conditional cdf

**Examples**

pcondnor(0.5, 0.6, 0.6)

---

pcondpla                    *Conditional Plackett (B2)*

---

**Description**

Conditional Plackett (B2)

**Usage**

pcondpla(u, v, cpar)

**Arguments**

u	values at which the cdf is evaluated
v	value of the conditioning variable in (0,1)
cpar	copula parameter >1

**Value**

ccdf	Conditional cdf
------	-----------------

**Examples**

```
pcondpla(0.5,0.6,2)
```

---

pcondt	<i>Conditional Student</i>
--------	----------------------------

---

**Description**

Conditional Student is  $Y_2|Y_1=y_1 \sim t(\nu+1, \text{location}=\rho*y_1, \text{sigma}(y_1))$ , where here  $\text{sigma}^2 = (1-\rho^2)(\nu+y_1^2)/(\nu+1)$

**Usage**

```
pcondt(u, v, cpar, dfC)
```

**Arguments**

u	values at which the cdf is evaluated
v	value of the conditioning variable in (0,1)
cpar	copula parameter
dfC	degrees of freedom

**Value**

ccdf	Conditional cdf
------	-----------------

**Examples**

```
pcondt(0.5,0.6,0.6,15)
```

---

poiscpdf	<i>Poisson cdf/pdf and ders</i>
----------	---------------------------------

---

**Description**

This function computes the cdf, pdf, and associated derivatives

**Usage**

```
poiscpdf(z, th)
```

**Arguments**

z	vector of responses
th	values of lambda > 0

**Value**

out	Matrix of conditional cdf, derivative with respect to parameter, pdf,
-----	---

**Author(s)**

Pavel Krupskii and Bruno N. Remillard, January 20, 2022

**Examples**

```
out = poiscpdf(0, 2.5)
```

---

predictContinuous	<i>Conditional expectation for a copula-based estimation of mixed regression models for continuous response</i>
-------------------	---

---

**Description**

Compute the conditional expectation of a copula-based 2-level hierarchical model for continuous response.

**Usage**

```
predictContinuous(object, newdata = NULL, nq = 25)
```

**Arguments**

object	Object of class “EstContinuous“ generated by EstContinuous.
newdata	List of variables for be predicted (“clu“ for clusters, “xc“ for the copula covariates, and “xm“ for the margins covariates). The covariates can be NULL.
nq	number of nodes and weighted for Gaussian quadrature of the product of conditional copulas; default is 25.

**Value**

mest	Conditional expectations
------	--------------------------

**Author(s)**

Pavel Krupskii and Bruno N. Remillard, January 20, 2023

**References**

Krupskii, Nasri & Remillard (2023). On factor copula-based mixed regression models

**Examples**

```
data(out.normal)
newdata=list(clu=c(1:50),xm=rep(0.4,50))
pred= predictContinuous(out.normal,newdata)
```

---

predictDiscrete	<i>Conditional expectation for a copula-based estimation of mixed regression models for discrete response</i>
-----------------	---

---

**Description**

Compute the conditional expectation of a copula-based 2-level hierarchical model for discrete response.

**Usage**

```
predictDiscrete(object, newdata, m = 100)
```

**Arguments**

object	Object of class “EstDiscrete“ generated by EstDiscrete.
newdata	List of variables for be predicted (“clu“ for clusters, “xc“ for the copula covariates, and “xm“ for the margins covariates). The covariates can be NULL.
m	Number of points for the numerical integration (default is 100).

**Value**

mest                      Conditional expectations (conditional probabilities for the multinomial case)

**Author(s)**

Pavel Krupskii and Bruno N. Remillard, January 20, 2023

**References**

Krupskii, Nasri & Remillard (2023). On factor copula-based mixed regression models

**Examples**

```
data(out.poisson)
newdata = list(clu=c(1:50),xc=rep(0.2,50),xm=rep(0.5,50))
pred= predictDiscrete(out.poisson,newdata,m=100)
```

---

pseudosC

*Estimation cdf, left-continuous cdf, and pseudo-observations*

---

**Description**

This function estimates the empirical cdf, its left limit, and pseudo-observations for a univariate vector  $y$

**Usage**

```
pseudosC(y)
```

**Arguments**

$y$                       univariate data

**Value**

$F_n$                       Empirical cdf  
 $F_m$                       Left-continuous cdf  
 $U$                         Pseudo-observations

**Author(s)**

Bruno N. Remillard, January 20, 2022

**Examples**

```
y = rpois(100,2)
out=pseudosC(y)
```



---

qcond	<i>Inverse conditional cdf</i>
-------	--------------------------------

---

**Description**

This function computes the quantile of conditional cdf  $C(U|v)$  for a copula  $C$

**Usage**

```
qcond(w, v, family, cpar, rot = 0)
```

**Arguments**

w	probability
v	value of the conditioning variable in (0,1)
family	"gaussian", "t", "clayton", "fgm", "frank", "gumbel", "plackett", "galambos", "huesler-reiss"
cpar	copula parameter (vector)
rot	rotation: 0 (default), 90, 180 (survival), or 270

**Value**

U	Conditional quantile
U	Conditional quantile

**Author(s)**

Pavel Krupskii and Bruno N. Remillard, January 20, 2022

**Examples**

```
U = qcond(0.1, 0.2, "gaussian", 0.87)
```

---

qcondcla	<i>Inverse clayton</i>
----------	------------------------

---

**Description**

Inverse clayton

**Usage**

```
qcondcla(w, v, th)
```

**Arguments**

w	probability
v	value of the conditioning variable in (0,1)
th	copula parameter

**Value**

out	Conditional quantile
-----	----------------------

---

qcondfgm	<i>Inverse FGM (B10)</i>
----------	--------------------------

---

**Description**

Inverse FGM (B10)

**Usage**

qcondfgm(w, v, th)

**Arguments**

w	probability
v	value of the conditioning variable in (0,1)
th	copula parameter $-1 \leq th \leq 1$

**Value**

out	Conditional quantile
-----	----------------------

---

qcondfra	<i>Inverse Frank</i>
----------	----------------------

---

**Description**

Inverse Frank

**Usage**

qcondfra(w, v, th)

**Arguments**

w            probability  
v            value of the conditioning variable in (0,1)  
th           copula parameter

**Value**

out           Conditional quantile

---

qcondgal            *Inverse Galambos*

---

**Description**

Inverse Galambos

**Usage**

qcondgal(w, v, th)

**Arguments**

w            probability  
v            value of the conditioning variable in (0,1)  
th           copula parameter >0

**Value**

out           Conditional quantile

---

qcondgum            *Inverse Gumbel*

---

**Description**

Inverse Gumbel

**Usage**

qcondgum(w, v, th)

**Arguments**

w	probability
v	value of the conditioning variable in (0,1)
th	copula parameter

**Value**

out	Conditional quantile
-----	----------------------

---

qcondhr	<i>Inverse Huesler-Reiss</i>
---------	------------------------------

---

**Description**

Inverse Huesler-Reiss

**Usage**

qcondhr(w, v, th)

**Arguments**

w	probability
v	value of the conditioning variable in (0,1)
th	copula parameter >0

**Value**

out	Conditional quantile
-----	----------------------

---

qcondjoe	<i>Inverse Joe</i>
----------	--------------------

---

**Description**

Inverse Joe

**Usage**

qcondjoe(w, v, th)

**Arguments**

w	probability
v	value of the conditioning variable in (0,1)
th	copula parameter >-1

**Value**

out	Conditional quantile
-----	----------------------

---

qcondnor	<i>Inverse Gaussian</i>
----------	-------------------------

---

**Description**

Inverse Gaussian

**Usage**

qcondnor(w, v, th)

**Arguments**

w	probability
v	value of the conditioning variable in (0,1)
th	copula parameter (correlation)

**Value**

out	Conditional quantile
-----	----------------------

---

qcondpla	<i>Inverse Plackett</i>
----------	-------------------------

---

**Description**

Inverse Plackett

**Usage**

qcondpla(w, v, th)

**Arguments**

w	probability
v	value of the conditioning variable in (0,1)
th	copula parameter

**Value**

out	Conditional quantile
-----	----------------------

---

qcondt	<i>Inverse Student</i>
--------	------------------------

---

**Description**

Inverse Student

**Usage**

```
qcondt(w, v, th)
```

**Arguments**

w	probability
v	value of the conditioning variable in (0,1)
th	copula parameter

**Value**

out	Conditional quantile
-----	----------------------

---

sim.poisson	<i>Simulated data</i>
-------------	-----------------------

---

**Description**

Simulated clustered data from a Frank copula with parC=c(2,8), and Poisson margins with parM=c(3.0,-0.1). Clusters and covariates (both uniform) are included.

**Usage**

```
data(sim.poisson)
```

**Format**

List of simulated values (y, clu,xc,xm) together with true parameters

**Examples**

```
data(sim.poisson)
```

---

 SimGenCluster

*Simulation of clustered data*


---

**Description**

Generate a random sample of observations from a copula-based mixed regression model.

**Usage**

```
SimGenCluster(
  parC,
  parM,
  clu,
  xc = NULL,
  xm = NULL,
  family,
  rot = 0,
  dfC = NULL,
  model,
  dfM = NULL,
  offset = NULL
)
```

**Arguments**

parC	vector of copula parameters; k1 is the number of covariates + constant for the copula
parM	vector of margin parameters; k2 is the number of covariates + constant for the margins
clu	vector of clusters (can be a factor)
xc	matrix (N x k1) of covariates for the copula, not including the constant (can be NULL)
xm	matrix (N x k2) of covariates for the margins, not including the constant (can be NULL)
family	copula family: "gaussian", "t", "clayton", "joe", "frank", "gumbel", "plackett"
rot	rotation: 0 (default), 90, 180 (survival), or 270
dfC	degrees of freedom for the Student copula (default is NULL)
model	marginal distribution: "binomial" (bernoulli), "poisson", "nbinom" (mean is the parameter), "nbinom1" (p is the parameter), "geometric", "multinomial", "exponential", "weibull", "normal" (gaussian), "t", "laplace"
dfM	degrees of freedom for the Student margins (default is NULL)
offset	offset for the margins (default is NULL)

**Value**

y                    Simulated response  
y                    Simulated values

**Author(s)**

Bruno N. Remillard

**Examples**

```
K=50 #number of clusters
n=5 #size of each cluster
N=n*K
set.seed(1)
clu=rep(c(1:K),each=n)
parC = 0 # yields tau = 0.5 for Clayton
parM= c(1,-1,4)
xm = runif(N)
y=SimGenCluster(parC,parM,xm,family="clayton",rot=90,clu=clu,model="gaussian")
```

---

SimMultinomial

*Simulation of multinomial clustered data*

---

**Description**

Generate a random sample of multinomial observations from a copula-based mixed regression model.

**Usage**

```
SimMultinomial(
  parC,
  parM,
  clu,
  xc = NULL,
  xm = NULL,
  family,
  rot = 0,
  dfC = NULL,
  offset = NULL
)
```

**Arguments**

parC                    copula parameters  
parM                    matrix of dimension (L-1)x k2 of margin parameters; L is the number of levels and k2 is the number of covariates+constant for the margins



clu	vector of clusters (can be a factor)
xc	matrix of covariates for the copula, not including the constant (can be NULL)
xm	matrix of covariates for the margins, not including the constant (can be NULL)
family	copula family: "gaussian", "t", "clayton", "joe", "frank", "gumbel", "plackett"
rot	rotation: 0 (default), 90, 180 (survival), or 270
dfc	degrees of freedom for student copula (default is NULL)
offset	offset for the margins (default is NULL)

**Value**

y	Simulated factor
---	------------------

**Author(s)**

Bruno N. Remillard

**Examples**

```

K=50 #number of clusters
n=5 #size of each cluster
N=n*K
set.seed(1)
clu=rep(c(1:K),each=n)
parC = 2
parM=matrix(c(1,-1,0.5,2),byrow=TRUE,ncol=2)
xm = runif(N)
y=SimMultinomial(parC,parM,clu,xm=xm,family="clayton",rot=90)

```

---

 tcpdf

---

*Student cdf/pdf and ders*


---

**Description**

This function computes the cdf, pdf, and associated derivatives

**Usage**

```
tcpdf(z, th, df)
```

**Arguments**

z	vector of responses
th	th[,1] is mean, th[,2] is standard deviation > 0
df	degrees of freedom

**Value**

out                    Matrix of conditional cdf, derivative with respect to parameter, pdf,

**Author(s)**

Pavel Krupskii and Bruno N. Remillard, January 20, 2022

**Examples**

```
out = tcpdf(2,c(-3,4),25)
```

---

weibcpdf

*Weibul cdf/pdf and ders*

---

**Description**

This function computes the cdf, pdf, and associated derivatives

**Usage**

```
weibcpdf(z, th)
```

**Arguments**

z                    vector of responses  
th                   th[,1] is rate>0, th[,2] is shape > 0;

**Value**

out                   Matrix of conditional cdf, derivative with respect to parameter, pdf,

**Author(s)**

Pavel Krupskii and Bruno N. Remillard, January 20, 2022

**Examples**

```
out = weibcpdf(2,c(2,3))
```

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