Package 'GFGM.copula'

April 2, 2018

Type Package

Title Generalized Farlie-Gumbel-Morgenstern Copula

Version 1.0.3

Date 2018-04-02

Author Jia-Han Shih

Maintainer Jia-Han Shih <tommy355097@gmail.com>

Description Compute bivariate dependence measures and perform bivariate competing risks analysis under the generalized Farlie-Gumbel-Morgenstern (FGM) copula. See Shih and Emura (2016) <doi:10.1007/s00362-016-0865-5> and Shih and Emura (2018) <doi:10.1007/s00180-018-0804-0> for details.

Depends cmprsk, compound.Cox, joint.Cox

License GPL-2

Encoding UTF-8

LazyData true

RoxygenNote 6.0.1

Repository CRAN

NeedsCompilation no

Date/Publication 2018-04-02 09:10:10 UTC

R topics documented:

GFGM.copula-package   *Generalized Farlie-Gumbel-Morgenstern Copula*

Description

Compute bivariate dependence measures and perform bivariate competing risks analysis under the generalized Farlie-Gumbel-Morgenstern (FGM) copula. See Shih and Emura (2016, 2018) for details.

Details

The functions in this package are based on latent failure time models with competing risks in Shih and Emura (2018). However, they can be adapted to dependent censoring models in Emura and Chen (2018). See `MLE.GFGM.spline` for example.

Author(s)

Jia-Han Shih

Maintainer: Jia-Han Shih <tommy355097@gmail.com>

References

Shih J-H, Emura T (2016) Bivariate dependence measures and bivariate competing risks models under the generalized FGM copula, Statistical Papers, doi: 10.1007/s00362-016-0865-5.

Shih J-H, Emura T (2018) Likelihood-based inference for bivariate latent failure time models with competing risks udner the generalized FGM copula, Computational Statistics, doi: 10.1007/s00180-018-0804-0.

Emura T, Chen Y-H (2018) Analysis of Survival Data with Dependent Censoring, Copula-Based Approaches, JSS Research Series in Statistics, Springer, in press.

CvM.GFGM.BurrIII   *The Cramer-von Mises type statistics under the generalized FGM copula*

Description

Compute the Cramer-von Mises type statistics under the generalized FGM copula.

Usage

```
CvM.GFGM.BurrIII(t.event, event1, event2, Alpha, Beta, Gamma, g1, g2, p, q,
  theta, eta = 0, Sdist.plot = TRUE)
```

Arguments

t.event	Vector of the observed failure times.
event1	Vector of the indicators for the failure cause 1.
event2	Vector of the indicators for the failure cause 2.
Alpha	Positive shape parameter for the Burr III margin (failure cause 1).
Beta	Positive shape parameter for the Burr III margin (failure cause 2).
Gamma	Common positive shape parameter for the Burr III margins.
g1	Splines coefficients for the failure cause 1.
g2	Splines coefficients for the failure cause 2.
p	Copula parameter that greater than or equal to 1.
q	Copula parameter that greater than 1 (integer).
theta	Copula parameter with restricted range.
eta	Location parameter with default value 0.
Sdist.plot	Plot sub-distribution functions if TRUE.

Details

The copula parameter q is restricted to be a integer due to the binominal theorem. The admissible range of theta is given in Dependence.GFGM.

Value

S.overall	Cramer-von Mises type statistic based on parametric and non-parametric estimators of sub-distribution functions for testing overall model.
S.GFGM	Cramer-von Mises type statistic based on semi-parametric and non-parametric estimators of sub-distribution functions for testing the generalized FGM copula.

References

Shih J-H, Emura T (2018) Likelihood-based inference for bivariate latent failure time models with competing risks udner the generalized FGM copula, Computational Statistics, doi: 10.1007/s00180-018-0804-0.

See Also

[Dependence.GFGM](#), [MLE.GFGM.BurrIII](#), [MLE.GFGM.spline](#)

Examples

```
con   = c(16,224,16,80,128,168,144,176,176,568,392,576,128,56,112,160,384,600,40,416,
          408,384,256,246,184,440,64,104,168,408,304,16,72,8,88,160,48,168,80,512,
          208,194,136,224,32,504,40,120,320,48,256,216,168,184,144,224,488,304,40,160,
          488,120,208,32,112,288,336,256,40,296,60,208,440,104,528,384,264,360,80,96,
          360,232,40,112,120,32,56,280,104,168,56,72,64,40,480,152,48,56,328,192,
          168,168,114,280,128,416,392,160,144,208,96,536,400,80,40,112,160,104,224,336,
          616,224,40,32,192,126,392,288,248,120,328,464,448,616,168,112,448,296,328,56,
```

```
         80,72,56,608,144,408,16,560,144,612,80,16,424,264,256,528,56,256,112,544,
         552,72,184,240,128,40,600,96,24,184,272,152,328,480,96,296,592,400,8,280,
         72,168,40,152,488,480,40,576,392,552,112,288,168,352,160,272,320,80,296,248,
         184,264,96,224,592,176,256,344,360,184,152,208,160,176,72,584,144,176)
uncon = c(368,136,512,136,472,96,144,112,104,104,344,246,72,80,312,24,128,304,16,320,
         560,168,120,616,24,176,16,24,32,232,32,112,56,184,40,256,160,456,48,24,
         200,72,168,288,112,80,584,368,272,208,144,208,114,480,114,392,120,48,104,272,
         64,112,96,64,360,136,168,176,256,112,104,272,320,8,440,224,280,8,56,216,
         120,256,104,104,8,304,240,88,248,472,304,88,200,392,168,72,40,88,176,216,
         152,184,400,424,88,152,184)
cen   = rep(630,44)

t.event = c(con,uncon,cen)
event1  = c(rep(1,length(con)),rep(0,length(uncon)),rep(0,length(cen)))
event2  = c(rep(0,length(con)),rep(1,length(uncon)),rep(0,length(cen)))

library(GFGM.copula)
#res.BurrIII = MLE.GFGM.BurrIII(t.event,event1,event2,5000,3,2,0.75,eta = -71)
#Alpha = res.BurrIII$Alpha[1]
#Beta = res.BurrIII$Beta[1]
#Gamma = res.BurrIII$Gamma[1]
#res.spline = MLE.GFGM.spline(t.event,event1,event2,3,2,0.75)
#g1 = res.spline$g1
#g2 = res.spline$g2
#CvM.GFGM.BurrIII(t.event,event1,event2,Alpha,Beta,Gamma,g1,g2,3,2,0.75,eta = -71)
```

Dependence.GFGM   *Bivariate dependence measures under the generalized FGM copula*

Description

Compute Kendall's tau and Spearman's rho with their boundaries under the generalized FGM copula.

Usage

```
Dependence.GFGM(p, q, theta)
```

Arguments

p   Copula parameter that greater than or equal to 1.

q   Copula parameter that greater than 1.

theta   Copula parameter with restricted range.

Details

The admissible range of theta (θ) is

$$-\min\left\{1, \frac{1}{p^{2q}}\left(\frac{1+pq}{q-1}\right)^{2q-2}\right\} \le \theta \le \frac{1}{p^q}\left(\frac{1+pq}{q-1}\right)^{q-1}.$$

See also Shih and Emura (2016) for details.

Value

theta	Dependence parameter.
tau	Kendall's tau.
rho	Spearman's rho.

References

Shih J-H, Emura T (2016) Bivariate dependence measures and bivariate competing risks models under the generalized FGM copula, Statistical Papers, doi: 10.1007/s00362-016-0865-5.

Examples

```
library(GFGM.copula)
Dependence.GFGM(3,2,0.75)
```

GFGM.BurrIII	*Generate samples from the generalized FGM copula with the Burr III margins*

Description

Generate samples from the generalized FGM copula with the Burr III margins.

Usage

```
GFGM.BurrIII(n, p, q, theta, Alpha, Beta, Gamma)
```

Arguments

n	Sample size.
p	Copula parameter that greater than or equal to 1.
q	Copula parameter that greater than 1.
theta	Copula parameter with restricted range.
Alpha	Positive shape parameter for the Burr III margin.
Beta	Positive shape parameter for the Burr III margin.
Gamma	Common positive shape parameter for the Burr III margins.

Details

The admissible range of theta is given in Dependence.GFGM.

Value

X	X is asscoiated with the parameter Alpha.
Y	Y is asscoiated with the parameter Beta.

References

Shih J-H, Emura T (2016) Bivariate dependence measures and bivariate competing risks models under the generalized FGM copula, Statistical Papers, doi: 10.1007/s00362-016-0865-5.

Shih J-H, Emura T (2018) Likelihood-based inference for bivariate latent failure time models with competing risks udner the generalized FGM copula, Computational Statistics, doi: 10.1007/s00180-018-0804-0.

See Also

Dependence.GFGM

Examples

```
library(GFGM.copula)
GFGM.BurrIII(5,3,2,0.75,1,1,1)
```

MLE.GFGM.BurrIII   *Maximum likelihood estimation for bivariate dependent competing risks data under the generalized FGM copula with the Burr III margins*

Description

Maximum likelihood estimation for bivariate dependent competing risks data under the generalized FGM copula with the Burr III margins.

Usage

```
MLE.GFGM.BurrIII(t.event, event1, event2, D, p, q, theta, eta = 0,
  Gamma.0 = 1, epsilon.0 = 1e-05, epsilon.1 = 1e-10, epsilon.2 = 1e-300,
  r.1 = 1, r.2 = 1, r.3 = 1)
```

Arguments

t.event	Vector of the observed failure times.
event1	Vector of the indicators for the failure cause 1.
event2	Vector of the indicators for the failure cause 2.
D	Positive tunning parameter in the NR algorithm.
p	Copula parameter that greater than or equal to 1.
q	Copula parameter that greater than 1 (integer).
theta	Copula parameter with restricted range.
eta	Location parameter with default value 0.
Gamma.0	Initial guess for the common shape parameter gamma with default value 1.
epsilon.0	Positive tunning parameter in the NR algorithm with default value 1e-5.
epsilon.1	Positive tunning parameter in the NR algorithm with default value 1e-10.
epsilon.2	Positive tunning parameter in the NR algorithm with default value 1e-300.
r.1	Positive tunning parameter in the NR algorithm with default value 1.
r.2	Positive tunning parameter in the NR algorithm with default value 1.
r.3	Positive tunning parameter in the NR algorithm with default value 1.

Details

The copula parameter q is restricted to be a integer due to the binominal theorem. The admissible range of theta is given in Dependence.GFGM.

Value

n	Sample size.
count	Iteration number.
random	Randomization number.
Alpha	Positive shape parameter for the Burr III margin (failure cause 1).
Beta	Positive shape parameter for the Burr III margin (failure cause 2).
Gamma	Common shape parameter for the Burr III margins.
MeanX	Mean lifetime due to failure cause 1.
MeanY	Mean lifetime due to failure cause 2.
logL	Log-likelihood value under the fitted model.

References

Shih J-H, Emura T (2016) Bivariate dependence measures and bivariate competing risks models under the generalized FGM copula, Statistical Papers, doi: 10.1007/s00362-016-0865-5.

Shih J-H, Emura T (2018) Likelihood-based inference for bivariate latent failure time models with competing risks udner the generalized FGM copula, Computational Statistics, doi: 10.1007/s00180-018-0804-0.

See Also

Dependence.GFGM

Examples

```
con   = c(16,224,16,80,128,168,144,176,176,568,392,576,128,56,112,160,384,600,40,416,
          408,384,256,246,184,440,64,104,168,408,304,16,72,8,88,160,48,168,80,512,
          208,194,136,224,32,504,40,120,320,48,256,216,168,184,144,224,488,304,40,160,
          488,120,208,32,112,288,336,256,40,296,60,208,440,104,528,384,264,360,80,96,
          360,232,40,112,120,32,56,280,104,168,56,72,64,40,480,152,48,56,328,192,
          168,168,114,280,128,416,392,160,144,208,96,536,400,80,40,112,160,104,224,336,
          616,224,40,32,192,126,392,288,248,120,328,464,448,616,168,112,448,296,328,56,
          80,72,56,608,144,408,16,560,144,612,80,16,424,264,256,528,56,256,112,544,
          552,72,184,240,128,40,600,96,24,184,272,152,328,480,96,296,592,400,8,280,
          72,168,40,152,488,480,40,576,392,552,112,288,168,352,160,272,320,80,296,248,
          184,264,96,224,592,176,256,344,360,184,152,208,160,176,72,584,144,176)
uncon = c(368,136,512,136,472,96,144,112,104,104,344,246,72,80,312,24,128,304,16,320,
          560,168,120,616,24,176,16,24,32,232,32,112,56,184,40,256,160,456,48,24,
          200,72,168,288,112,80,584,368,272,208,144,208,114,480,114,392,120,48,104,272,
          64,112,96,64,360,136,168,176,256,112,104,272,320,8,440,224,280,8,56,216,
          120,256,104,104,8,304,240,88,248,472,304,88,200,392,168,72,40,88,176,216,
          152,184,400,424,88,152,184)
cen   = rep(630,44)

t.event = c(con,uncon,cen)
event1  = c(rep(1,length(con)),rep(0,length(uncon)),rep(0,length(cen)))
event2  = c(rep(0,length(con)),rep(1,length(uncon)),rep(0,length(cen)))

library(GFGM.copula)
MLE.GFGM.BurrIII(t.event,event1,event2,5000,3,2,0.75,eta = -71)
```

MLE.GFGM.spline	*Maximum likelihood estimation for bivariate dependent competing risks data under the generalized FGM copula with the marginal distributions approximated by splines*

Description

Maximum likelihood estimation for bivariate dependent competing risks data under the generalized FGM copula with the marginal distributions approximated by splines.

Usage

```
MLE.GFGM.spline(t.event, event1, event2, p, q, theta, h.plot = TRUE)
```

Arguments

`t.event`	Vector of the observed failure times.
`event1`	Vector of the indicators for the failure cause 1.
`event2`	Vector of the indicators for the failure cause 2.
`p`	Copula parameter that greater than or equal to 1.
`q`	Copula parameter that greater than 1 (integer).
`theta`	Copula parameter with restricted range.
`h.plot`	Plot hazard functions if TRUE.

Details

The copula parameter `q` is restricted to be a integer due to the binominal theorem. The admissible range of `theta` is given in `Dependence.GFGM`.

To adapt our functions to dependent censoring models in Emura and Chen (2018), one can simply set `event2 = 1-event1` (See examples).

Value

`n`	Sample size.
`g1`	Maximum likelihood estimator of the splines coefficients for the failure cause 1.
`g2`	Maximum likelihood estimator of the splines coefficients for the failure cause 2.
`g1.var`	Covariance matrix of splines coefficients estimates for the failure cause 1.
`g2.var`	Covariance matrix of splines coefficients estimates for the failure cause 2.

References

Shih J-H, Emura T (2016) Bivariate dependence measures and bivariate competing risks models under the generalized FGM copula, Statistical Papers, doi: 10.1007/s00362-016-0865-5.

Shih J-H, Emura T (2018) Likelihood-based inference for bivariate latent failure time models with competing risks udner the generalized FGM copula, Computational Statistics, doi: 10.1007/s00180-018-0804-0.

Emura T, Chen Y-H (2018) Analysis of Survival Data with Dependent Censoring, Copula-Based Approaches, JSS Research Series in Statistics, Springer, in press.

See Also

Dependence.GFGM

Examples

```
con   = c(16,224,16,80,128,168,144,176,176,568,392,576,128,56,112,160,384,600,40,416,
          408,384,256,246,184,440,64,104,168,408,304,16,72,8,88,160,48,168,80,512,
          208,194,136,224,32,504,40,120,320,48,256,216,168,184,144,224,488,304,40,160,
          488,120,208,32,112,288,336,256,40,296,60,208,440,104,528,384,264,360,80,96,
          360,232,40,112,120,32,56,280,104,168,56,72,64,40,480,152,48,56,328,192,
```

```
           168,168,114,280,128,416,392,160,144,208,96,536,400,80,40,112,160,104,224,336,
           616,224,40,32,192,126,392,288,248,120,328,464,448,616,168,112,448,296,328,56,
           80,72,56,608,144,408,16,560,144,612,80,16,424,264,256,528,56,256,112,544,
           552,72,184,240,128,40,600,96,24,184,272,152,328,480,96,296,592,400,8,280,
           72,168,40,152,488,480,40,576,392,552,112,288,168,352,160,272,320,80,296,248,
           184,264,96,224,592,176,256,344,360,184,152,208,160,176,72,584,144,176)
uncon = c(368,136,512,136,472,96,144,112,104,104,344,246,72,80,312,24,128,304,16,320,
           560,168,120,616,24,176,16,24,32,232,32,112,56,184,40,256,160,456,48,24,
           200,72,168,288,112,80,584,368,272,208,144,208,114,480,114,392,120,48,104,272,
           64,112,96,64,360,136,168,176,256,112,104,272,320,8,440,224,280,8,56,216,
           120,256,104,104,8,304,240,88,248,472,304,88,200,392,168,72,40,88,176,216,
           152,184,400,424,88,152,184)
cen   = rep(630,44)

t.event = c(con,uncon,cen)
event1  = c(rep(1,length(con)),rep(0,length(uncon)),rep(0,length(cen)))
event2  = c(rep(0,length(con)),rep(1,length(uncon)),rep(0,length(cen)))

library(GFGM.copula)
MLE.GFGM.spline(t.event,event1,event2,3,2,0.75)

### dependent censoring ###

library(compound.Cox)
library(GFGM.copula)
data(Lung)
t.vec = Lung$t.vec
d.vec = Lung$d.vec

MLE.GFGM.spline(t.vec,d.vec,1-d.vec,3,2,-0.6)
```

Sdist.GFGM.BurrIII	*Sub-distribution functions under the generalized FGM copula with the Burr III margins*

Description

Sub-distribution functions under the generalized FGM copula with the Burr III margins.

Usage

```
Sdist.GFGM.BurrIII(time, Alpha, Beta, Gamma, p, q, theta, eta = 0)
```

Arguments

time	Vector of times.
Alpha	Positive shape parameter for the Burr III margin (failure cause 1).
Beta	Positive shape parameter for the Burr III margin (failure cause 2).
Gamma	Common positive shape parameter for the Burr III margins.

p	Copula parameter that greater than or equal to 1.
q	Copula parameter that greater than 1 (integer).
theta	Copula parameter with restricted range.
eta	Location parameter with default value 0.

Details

The copula parameter q is restricted to be a integer due to the binominal theorem. The admissible range of `theta` is given in `Dependence.GFGM`.

Value

time	Failure times
Sdist.1	Probability of an object fails due to the failure cause 1.
Sdist.2	Probability of an object fails due to the failure cause 2.

References

Shih J-H, Emura T (2016) Bivariate dependence measures and bivariate competing risks models under the generalized FGM copula, Statistical Papers, doi: 10.1007/s00362-016-0865-5.

Shih J-H, Emura T (2018) Likelihood-based inference for bivariate latent failure time models with competing risks udner the generalized FGM copula, Computational Statistics, doi: 10.1007/s00180-018-0804-0.

See Also

[MLE.GFGM.BurrIII](#), [Dependence.GFGM](#)

Examples

```
library(GFGM.copula)
Sdist.GFGM.BurrIII(c(1:5),1,1,1,3,2,0.75,eta = 1)
```

Sdist.GFGM.spline	*Sub-distribution functions under the generalized FGM copula with the marginal distributions approximated by splines*

Description

Sub-distribution functions under the generalized FGM copula with the marginal distributions approximated by splines.

Usage

```
Sdist.GFGM.spline(time, g1, g2, tmin, tmax, p, q, theta)
```

Arguments

time	Vector of times.
g1	Splines coefficients for the failure cause 1.
g2	Splines coefficients for the failure cause 2.
tmin	Lower bound of times.
tmax	upper bound of times.
p	Copula parameter that greater than or equal to 1.
q	Copula parameter that greater than 1 (integer).
theta	Copula parameter with restricted range.

Details

The splines coefficients g1 and g2 are usually computed by `MLE.GFGM.spline`. The copula parameter q is restricted to be a integer due to the binominal theorem. The admissible range of `theta` is given in `Dependence.GFGM`.

Value

time	Failure times
Sdist.1	Probability of an object fails due to the failure cause 1.
Sdist.2	Probability of an object fails due to the failure cause 2.

References

Shih J-H, Emura T (2016) Bivariate dependence measures and bivariate competing risks models under the generalized FGM copula, Statistical Papers, doi: 10.1007/s00362-016-0865-5.

Shih J-H, Emura T (2018) Likelihood-based inference for bivariate latent failure time models with competing risks udner the generalized FGM copula, Computational Statistics, doi: 10.1007/s00180-018-0804-0.

See Also

[MLE.GFGM.spline](), [Dependence.GFGM]()

Examples

```
library(GFGM.copula)
Sdist.GFGM.spline(seq(1,5,1),rep(0.1,5),rep(0.1,5),1,5,3,2,0.75)
```

Index