Package ‘GTDL’

October 12, 2022

Type Package

Title The Generalized Time-Dependent Logistic Family

Version 1.0.0

Date 2022-03-25

Author Jalmar Carrasco [aut, cre],
Luciano Santana [aut],
Lizandra Fabio [aut]

Maintainer Jalmar Carrasco <carrascojalmar@gmail.com>

Description Computes the probability density, survival function,
the hazard rate functions and generates random samples from the
GTDL distribution given by Mackenzie, G. (1996) <doi:10.2307/2348408>.
The likelihood estimates, the randomized quantile (Louzada, F., et al.
(2020) <doi:10.1109/ACCESS.2020.3040525>)
residuals and the normally transformed randomized survival
probability (Li,L., et al. (2021) <doi:10.1002/sim.8852>)
residuals are obtained for the GTDL model.

License GPL (>= 3)

Encoding UTF-8

LazyData TRUE

RoxygenNote 7.1.1

Imports survival,

Suggests stats,

Depends R (>= 2.10)

NeedsCompilation no

Repository CRAN

Date/Publication 2022-03-28 07:50:12 UTC

R topics documented:

`artset1987` *Artset1987 data*

Description

Times to failure of 50 devices put on life test at time 0.

Usage

```
data(artset1987)
```

Format

This data frame contains the following columns:

- t: Times to failure

References

- Aarset, M. V. (1987). How to Identify a Bathtub Hazard Rate. IEEE Transactions on Reliability, 36, 106–108.

Examples

```
data(artset1987)
head(artset1987)
```

fGTDL *The GTDL distribution*

Description

Density function, survival function, failure function and random generation for the GTDL distribution.

Usage

```
dGTDL(t, param, log = FALSE)

hGTDL(t, param)

sGTDL(t, param)

rGTDL(n, param)
```

Arguments

`t`	vector of integer positive quantile.
`param`	parameters (alpha and gamma are scalars, lambda non-negative).
`log`	logical; if TRUE, probabilities p are given as log(p).
`n`	number of observations.

Details

- Density function

$$f(t \mid \boldsymbol{\theta}) = \lambda \left(\frac{\exp\{\alpha t + \boldsymbol{X}^\top \boldsymbol{\beta}\}}{1 + \exp\{\alpha t + \boldsymbol{X}^\top \boldsymbol{\beta}\}} \right) \times \left(\frac{1 + \exp\{\alpha t + \boldsymbol{X}^\top \boldsymbol{\beta}\}}{1 + \exp\{\boldsymbol{X}^\top \boldsymbol{\beta}\}} \right)^{-\lambda/\alpha}$$

- Survival function

$$S(t \mid \boldsymbol{\theta}) = \left(\frac{1 + \exp\{\alpha t + \boldsymbol{X}^\top \boldsymbol{\beta}\}}{1 + \exp\{\boldsymbol{X}^\top \boldsymbol{\beta}\}} \right)^{-\lambda/\alpha}$$

- Failure function

$$h(t \mid \boldsymbol{\theta}) = \lambda \left(\frac{\exp\{\alpha t + \boldsymbol{X}^\top \boldsymbol{\beta}\}}{1 + \exp\{\alpha t + \boldsymbol{X}^\top \boldsymbol{\beta}\}} \right)$$

Value

`dGTDL` gives the density function, `hGTDL` gives the failure function, `sGTDL` gives the survival function and `rGTDL` generates random samples.

Invalid arguments will return an error message.

Source

[d-p-q-r]GTDL are calculated directly from the definitions.

References

- Mackenzie, G. (1996). Regression Models for Survival Data: The Generalized Time-Dependent Logistic Family. Journal of the Royal Statistical Society. Series D (The Statistician). 45. 21-34.

Examples

```
library(GTDL)
t <- seq(0,20,by = 0.1)
lambda <- 1.00
alpha <- -0.05
gamma <- -1.00
param <- c(lambda,alpha,gamma)
y1 <- hGTDL(t,param)
y2 <- sGTDL(t,param)
y3 <- dGTDL(t,param,log = FALSE)
tt <- as.matrix(cbind(t,t,t))
yy <- as.matrix(cbind(y1,y2,y3))
matplot(tt,yy,type="l",xlab="time",ylab="",lty = 1:3,col=1:3,lwd=2)


y1 <- hGTDL(t,c(1,0.5,-1.0))
y2 <- hGTDL(t,c(1,0.25,-1.0))
y3 <- hGTDL(t,c(1,-0.25,1.0))
y4 <- hGTDL(t,c(1,-0.50,1.0))
y5 <- hGTDL(t,c(1,-0.06,-1.6))
tt <- as.matrix(cbind(t,t,t,t,t))
yy <- as.matrix(cbind(y1,y2,y3,y4,y5))
matplot(tt,yy,type="l",xlab="time",ylab="Hazard function",lty = 1:3,col=1:3,lwd=2)
```

`mle1.GTDL` *Maximum likelihood estimation*

Description

Estimate of the parameters.

Usage

```
mle1.GTDL(start, t, method = "BFGS")
```

Arguments

`start`	Initial values for the parameters to be optimized over.
`t`	non-negative random variable representing the failure time and leave the snapshot failure rate, or danger.
`method`	The method to be used.

Value

Returns a list of summary statistics of the fitted GTDL distribution.

References

- Aarset, M. V. (1987). How to Identify a Bathtub Hazard Rate. IEEE Transactions on Reliability, 36, 106–108.
- Mackenzie, G. (1996) Regression Models for Survival Data: The Generalized Time-Dependent Logistic Family. Journal of the Royal Statistical Society. Series D (The Statistician). 45. 21-34.

See Also

`optim`

Examples

```
# times data (from Aarset, 1987))
data(artset1987)
mod <- mle1.GTDL(c(1,-0.05,-1),t = artset1987)
```

`mle2.GTDL` *Maximum likelihood estimates of the GTDL model*

Description

Maximum likelihood estimates of the GTDL model

Usage

```
mle2.GTDL(t, start, formula, censur, method = "BFGS")
```

Arguments

t	non-negative random variable representing the failure time and leave the snap-shot failure rate, or danger.
start	Initial values for the parameters to be optimized over.
formula	The structure matrix of covariates of dimension n x p.
censur	censoring status 0=censored, a=fail.
method	The method to be used.

Value

Returns a list of summary statistics of the fitted GTDL model.

References

- Mackenzie, G. (1996) Regression Models for Survival Data: The Generalized Time-Dependent Logistic Family. Journal of the Royal Statistical Society. Series D (The Statistician). (45). 21-34.

See Also

optim

Examples

```
### Example 1

require(survival)
data(lung)

lung <- lung[-14,]
lung$sex <- ifelse(lung$sex==2, 1, 0)
lung$ph.ecog[lung$ph.ecog==3]<-2
t1 <- lung$time
start1 <- c(0.03,0.05,-1,0.7,2,-0.1)
formula1 <- ~lung$sex+factor(lung$ph.ecog)+lung$age
censur1 <- ifelse(lung$status==1,0,1)
fit.model1 <- mle2.GTDL(t = t1,start = start1,
                     formula = formula1,
                     censur = censur1)
fit.model1

### Example 2

data(tumor)
t2 <- tumor$time
start2 <- c(1,-0.05,1.7)
formula2 <- ~tumor$group
censur2 <- tumor$censured
fit.model2 <- mle2.GTDL(t = t2,start = start2,
```

```
                             formula = formula2,
                             censur = censur2)
fit.model2
```

---

nrsp.GTDL *Normally-transformed randomized survival probability residuals for the GTDL model*

Description

Normally-transformed randomized survival probability residuals for the GTDL model

Usage

```
nrsp.GTDL(t, formula, pHat, censur)
```

Arguments

t	non-negative random variable representing the failure time and leave the snapshot failure rate, or danger.
formula	The structure matrix of covariates of dimension n x p.
pHat	Estimate of the parameters from the GTDL model.
censur	Censoring status 0=censored, a=fail.

Value

Normally-transformed randomized survival probability residuals

References

- Li, L., Wu, T., e Cindy, F. (2021). Model diagnostics for censored regression via randomized survival probabilities. Statistics in Medicine, 40, 1482–1497.
- de Oliveira, L. E. F., dos Santos L. S., da Silva, P. H. F., Fabio, L. C., Carrasco, J. M. F.(2022). Análise de resíduos para o modelo logístico generalizado dependente do tempo (GTDL). Submitted.

Examples

```
### Example 1

require(survival)
data(lung)
lung <- lung[-14,]
lung$sex <- ifelse(lung$sex==2, 1, 0)
lung$ph.ecog[lung$ph.ecog==3]<-2
t1 <- lung$time
```

```
formula1 <- ~lung$sex+factor(lung$ph.ecog)+lung$age
censur1 <- ifelse(lung$status==1,0,1)
start1 <- c(0.03,0.05,-1,0.7,2,-0.1)
fit.model1 <- mle2.GTDL(t = t1,start = start1,
           formula = formula1,
           censur = censur1)
r1 <- nrsp.GTDL(t = t1,formula = formula1 ,pHat = fit.model1$Coefficients[,1],
             censur = censur1)
r1

### Example 2

data(tumor)
t2 <- tumor$time
formula2 <- ~tumor$group
censur2 <- tumor$censured
start2 <- c(1,-0.05,1.7)
fit.model2 <- mle2.GTDL(t = t2,start = start2,
                       formula = formula2,
                       censur = censur2)
r2 <- nrsp.GTDL(t = t2,formula = formula2, pHat = fit.model2$Coefficients[,1],
            censur = censur2)
r2
```

`random.quantile.GTDL` *Randomized quantile residuals for the GTDL model*

Description

Randomized quantile residuals for the GTDL model

Usage

```
random.quantile.GTDL(t, formula, pHat, censur)
```

Arguments

`t`	non-negative random variable representing the failure time and leave the snapshot failure rate, or danger.
`formula`	The structure matrix of covariates of dimension n x p.
`pHat`	Estimate of the parameters from the GTDL model.
`censur`	censoring status 0=censored, a=fail.

Details

The randomized quantile residual (Dunn and Smyth, 1996), which follow a standard normal distribution is used to assess departures from the GTDL model.

Value

Randomized quantile residuals

References

- Dunn, P. K. e Smyth, G. K. (1996). Randomized quantile residuals. Journal of Computational and Graphical Statistics, 5, 236–244.
- Louzada, F., Cuminato, J. A., Rodriguez, O. M. H., Tomazella, V. L. D., Milani, E. A., Ferreira, P. H., Ramos, P. L., Bochio, G., Perissini, I. C., Junior, O. A. G., Mota, A. L., Alegr´ıa, L. F. A., Colombo, D., Oliveira, P. G. O., Santos, H. F. L., e Magalh~aes, M. V. C. (2020). Incorporation of frailties into a non-proportional hazard regression model and its diagnostics for reliability modeling of downhole safety valves. IEEE Access, 8, 219757 – 219774.
- de Oliveira, L. E. F., dos Santos L. S., da Silva, P. H. F., Fabio, L. C., Carrasco, J. M. F.(2022). Análise de resíduos para o modelo logístico generalizado dependente do tempo (GTDL). Submitted.

Examples

```
### Example 1

require(survival)
data(lung)
lung <- lung[-14,]
lung$sex <- ifelse(lung$sex==2, 1, 0)
lung$ph.ecog[lung$ph.ecog==3]<-2
t1 <- lung$time
formula1 <- ~lung$sex+factor(lung$ph.ecog)+lung$age
censur1 <- ifelse(lung$status==1,0,1)
start1 <- c(0.03,0.05,-1,0.7,2,-0.1)
fit.model1 <- mle2.GTDL(t = t1,start = start1,
           formula = formula1,
           censur = censur1)
r1 <- random.quantile.GTDL(t = t1,formula = formula1 ,pHat = fit.model1$Coefficients[,1],
             censur = censur1)
r1

### Example 2

data(tumor)
t2 <- tumor$time
formula2 <- ~tumor$group
censur2 <- tumor$censured
start2 <- c(1,-0.05,1.7)
fit.model2 <- mle2.GTDL(t = t2,start = start2,
                       formula = formula2,
                       censur = censur2)
r2 <- random.quantile.GTDL(t = t2,formula = formula2, pHat = fit.model2$Coefficients[,1],
            censur = censur2)
r2
```

tumor *Tumor data*

Description

Times (in days) of patients in ovarian cancer study

Usage

```
data(tumor)
```

Format

This data frame contains the following columns:

- time: survival time in days
- censured: censored = 0, dead = 1
- group: large tumor = 0, small tumor = 1

References

- Colosimo, E. A and Giolo, S. R. Análise de Sobrevivência Aplicada. Edgard Blucher: São Paulo. 2006.

Examples

```
data(tumor)
head(tumor)
```

Index