Package 'HazReg'

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Type Package

Title Parametric hazard-based regression models

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Description The HazReg R package implements the following parametric hazard-based regression models for survival data, in the overall and relative survival frameworks.

License What license is it under?

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Imports numDeriv, matrixStats

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`chew` *Power Exponentiated Weibull (EW) cumulative hazard function. https://rpubs.com/FJRubio/EWD*

Description

Power Exponentiated Weibull (EW) cumulative hazard function. https://rpubs.com/FJRubio/EWD

Usage

```
chew(t, sigma, nu, gamma)
```

Arguments

`t`	: positive argument
`sigma`	: scale parameter
`nu`	: shape parameter
`gamma`	: shape parameter

Value

the value of the EW cumulative hazard function

`chgamma` *Gamma (G) cumulative hazard function.*

Description

Gamma (G) cumulative hazard function.

Usage

```
chgamma(t, shape, scale)
```

Arguments

t	: positive argument
shape	: shape parameter
scale	: scale parameter
log:	log scale (TRUE or FALSE)

Value

the value of the Weibull hazard function

`chggamma` *Generalised Gamma (GG) cumulative hazard function. https://rpubs.com/FJRubio/GG*

Description

Generalised Gamma (GG) cumulative hazard function. https://rpubs.com/FJRubio/GG

Usage

```
chggamma(t, sigma, nu, gamma)
```

Arguments

t	: positive argument
sigma	: scale parameter
nu	: shape parameter
gamma	: shape parameter

Value

the value of the GG cumulative hazard function

`chllogis` *Log-logistic (LL) cumulative hazard function.*

Description

Log-logistic (LL) cumulative hazard function.

Usage

```
chllogis(t, mu, sigma)
```

Arguments

t	: positive argument
mu	: mean parameter in the log scale
sigma	: scale parameter in the log scale

Value

the value of the LL cumulative hazard function

`chlnorm` *Lognormal (LN) cumulative hazard function.*

Description

Lognormal (LN) cumulative hazard function.

Usage

```
chlnorm(t, mu, sigma)
```

Arguments

`t`	: positive argument
`mu`	: mean parameter in the log scale
`sigma`	: scale parameter in the log scale

Value

the value of the LN cumulative hazard function

`chpgw` *Power Generalised Weibull (PGW) cumulative hazard function. http://rpubs.com/FJRubio/PGW*

Description

Power Generalised Weibull (PGW) cumulative hazard function. http://rpubs.com/FJRubio/PGW

Usage

```
chpgw(t, sigma, nu, gamma)
```

Arguments

`t`	: positive argument
`sigma`	: scale parameter
`nu`	: shape parameter
`gamma`	: shape parameter

Value

the value of the PGW cumulative hazard function

chweibull *Weibull (W) cumulative hazard function.*

Description

Weibull (W) cumulative hazard function.

Usage

```
chweibull(t, sigma, nu)
```

Arguments

t	: positive argument
sigma	: scale parameter
nu	: shape parameter

Value

the value of the Weibull cumulative hazard function

CH_TVC *Compute the Cumulative Hazard for a Proportional Hazards or Accelerated Failure Model (2- and 3-parameter baseline)*

Description

Computes the cumulative hazard $H(t \mid x(t))$ at multiple time points for each individual under a proportional hazards (PH) model or Accelerated Failure Time (AFT) model with a two-parameter or three-parameter parametric baseline hazard.

Usage

```
CH_TVC(df, beta, npar, ae0, be0, ce0 = NULL, chfun, hstr)
```

Arguments

df	A data frame containing: • 'time': numeric vector of time points. • Covariate columns named with prefix '"des"' (e.g., 'des1', 'des2', ...), representing $x(t)$.
beta	Numeric vector of regression coefficients.
npar	Number of parameters in the baseline hazard (2 or 3).
ae0, be0, ce0	Numeric baseline parameters of the cumulative hazard.
chfun	A function computing the baseline cumulative hazard: 'chfun(time, ae0, be0, ce0)'.
hstr	Hazard structure ("PH" or "AFT")

Details

The PH model assumes

$$H(t \mid x(t)) = H_0(t; a_0, b_0, c_0) \exp(x(t)^\top \beta).$$

In the AFT model, event time is rescaled as

$$H(t \mid x(t)) = H_0(t \exp(x(t)^\top \beta); a_0, b_0, c_0).$$

Value

A numeric vector with the cumulative hazard evaluated at each time point in ‘df‘.

`Conf_Int` *Function to calculate the normal confidence intervals. The parameters indicated with "index" are transformed to the real line using log().*

Description

Function to calculate the normal confidence intervals. The parameters indicated with "index" are transformed to the real line using log().

Usage

```
Conf_Int(FUN, MLE, level = 0.95, index = NULL)
```

Arguments

`FUN`	: minus log-likelihood function to be used to calculate the confidence intervals
`MLE`	: maximum likelihood estimator of the parameters of interest
`level`	: confidence level
`index`	: position of the positive parameters under the original parameterisation

Value

a list containing the upper and lower conf.int limits, the transformed MLE, and std errors

dggamma *Generalised Gamma (GG) probability density function. https://rpubs.com/FJRubio/GG*

Description

Generalised Gamma (GG) probability density function. https://rpubs.com/FJRubio/GG

Usage

```
dggamma(t, sigma, nu, gamma, log = FALSE)
```

Arguments

t	: positive argument
sigma	: scale parameter
nu	: shape parameter
gamma	: shape parameter
log:	log scale (TRUE or FALSE)

Value

the value of the GG probability density function

dpgw *Power Generalised Weibull (PGW) probability density function. http://rpubs.com/FJRubio/PGW*

Description

Power Generalised Weibull (PGW) probability density function. http://rpubs.com/FJRubio/PGW

Usage

```
dpgw(t, sigma, nu, gamma, log = FALSE)
```

Arguments

t	: positive argument
sigma	: scale parameter
nu	: shape parameter
gamma	: shape parameter
log:	log scale (TRUE or FALSE)

Value

the value of the PGW probability density function

GEHMLE *Relative (Net) Survival models Log likelihood and MLE for the GH excess hazards model. Baseline hazards: Lognormal, Log-logistic, Gamma, PGW, EW, GG*

Description

Relative (Net) Survival models Log likelihood and MLE for the GH excess hazards model. Baseline hazards: Lognormal, Log-logistic, Gamma, PGW, EW, GG

Usage

```
GEHMLE(
  init,
  times,
  status,
  hp,
  hstr = NULL,
  dist = NULL,
  des = NULL,
  des_t = NULL,
  method = "Nelder-Mead",
  maxit = 100
)
```

Arguments

init	: initial point for optimisation step under the parameterisation (log(scale), log(shape1), log(shape2), alpha, beta) for scale-shape1-shape2 models or (mu, log(scale), alpha, beta) for log-location scale models.
times	: times to event
status	: vital status indicators (TRUE or 1 = observed, FALSE or 0 = censored)
hp	: population hazard (for all individuals)
hstr	: hazard structure: No covariates ("baseline"), AFT model with PGW baseline hazard ("AFT"), PH model with PGW baseline hazard ("PH"), AH model with PGW baseline hazard ("AH"), GH model with PGW baseline hazard ("GH") *GH is not available with Weibull dist
dist	: distribution for the baseline hazard: Power Generalised Weibull ("PGW") Generalised Gamma ("GenGamma")) Exponentiated Weibull ("EW") Weibull ("Weibull") Gamma ("Gamma") LogNormal ("LogNormal") LogLogistic ("LogLogistic")
des	: design matrix for hazard-level effects
des_t	: design matrix for time-level effects (it is recommended not to use splines here)
method	: "nlminb" or optimisation method to be used in optim (see ?optim)
maxit	: maximum number of iterations in optim or nlminb

Value

It returns the output from optim or nlminb for the selected model and the negative log likelihood function

GHMLE *GHMLE function: Hazard Regression Models with a parametric baseline hazard*

Description

GHMLE function: Hazard Regression Models with a parametric baseline hazard

Usage

```
GHMLE(
  init,
  times,
  status,
  hstr = NULL,
  dist = NULL,
  des = NULL,
  des_t = NULL,
  method = "Nelder-Mead",
  maxit = 100
)
```

Arguments

init	: initial point for optimisation step under the parameterisation (log(scale), log(shape1), log(shape2), alpha, beta) for scale-shape1-shape2 models or (mu, log(scale), alpha, beta) for log-location scale models.
times	: times to event
status	: vital status indicators (TRUE or 1 = observed, FALSE or 0 = censored)
hstr	: hazard structure: No covariates ("baseline"), AFT model with PGW baseline hazard ("AFT"), PH model with PGW baseline hazard ("PH"), AH model with PGW baseline hazard ("AH"), GH model with PGW baseline hazard ("GH") *GH is not available with Weibull dist
dist	: distribution for the baseline hazard: Power Generalised Weibull ("PGW") Generalised Gamma ("GenGamma")) Exponentiated Weibull ("EW") Weibull ("Weibull") Gamma ("Gamma") LogNormal ("LogNormal") LogLogistic ("LogLogistic")
des	: design matrix for hazard-level effects
des_t	: design matrix for time-level effects (it is recommended not to use splines here)
method	: "nlminb" or optimisation method to be used in optim (see ?optim)
maxit	: maximum number of iterations in optim or nlminb

Value

It returns the output from optim or nlminb for the selected model and the negative log likelihood function

---

hew *Power Exponentiated Weibull (EW) hazard function. https://rpubs.com/FJRubio/EWD*

Description

Power Exponentiated Weibull (EW) hazard function. https://rpubs.com/FJRubio/EWD

Usage

```
hew(t, sigma, nu, gamma, log = FALSE)
```

Arguments

t	: positive argument
sigma	: scale parameter
nu	: shape parameter
gamma	: shape parameter
log:	log scale (TRUE or FALSE)

Value

the value of the EW hazard function

---

hgamma *Gamma (G) hazard function.*

Description

Gamma (G) hazard function.

Usage

```
hgamma(t, shape, scale, log = FALSE)
```

Arguments

t	: positive argument
shape	: shape parameter
scale	: scale parameter
log:	log scale (TRUE or FALSE)

Value

the value of the Gamma hazard function

hggamma *Generalised Gamma (GG) hazard function. https://rpubs.com/FJRubio/GG*

Description

Generalised Gamma (GG) hazard function. https://rpubs.com/FJRubio/GG

Usage

```
hggamma(t, sigma, nu, gamma, log = FALSE)
```

Arguments

t	: positive argument
sigma	: scale parameter
nu	: shape parameter
gamma	: shape parameter
log:	log scale (TRUE or FALSE)

Value

the value of the GG hazard function

hllogis *Log-logistic (LL) hazard function.*

Description

Log-logistic (LL) hazard function.

Usage

```
hllogis(t, mu, sigma, log = FALSE)
```

Arguments

t	: positive argument
mu	: mean parameter in the log scale
sigma	: scale parameter in the log scale
log:	log scale (TRUE or FALSE)

Value

the value of the LL hazard function

`hlnorm` *Lognormal (LN) hazard function.*

Description

Lognormal (LN) hazard function.

Usage

```
hlnorm(t, mu, sigma, log = FALSE)
```

Arguments

`t`	: positive argument
`mu`	: mean parameter in the log scale
`sigma`	: scale parameter in the log scale
`log:`	log scale (TRUE or FALSE)

Value

the value of the LN hazard function

`HMLE_TVC` *Maximum Likelihood Estimation for Parametric Hazard Models with Time-Varying Covariates*

Description

'HMLE_TVC()' fits parametric survival models in the presence of **time-varying covariates**, using maximum likelihood estimation.

The function supports:

* **Proportional Hazards (PH)** models with time-varying covariates * Fully parametric baseline hazards (2-parameter or 3-parameter)

The likelihood is constructed from the cumulative hazard differences across observation intervals for each individual, using a counting-process representation.

For each individual, the data must contain several rows: one per time-varying covariate measurement, along with the corresponding time.

Usage

```
HMLE_TVC(
  init,
  df,
  status,
  hstr = NULL,
  dist = NULL,
  des = NULL,
  method = "Nelder-Mead",
  maxit = 100
)
```

Arguments

df	A data frame in **long format**, containing one row per individual per covariate-measurement time. Required columns: * 'ID' — individual identifier * 'time' — time at which the covariates are measured * 'status' — event indicator (1 = event at the final time; 0 = censored) * 'des*' — covariate columns used in the model (e.g., 'des1', 'des2', ...) The last row for each ID represents the individual's event/censoring time, even if the event time does not coincide with a measurement time.
method	Optimisation method for the likelihood. Either '"nlminb"' or a valid 'optim()' method.
maxit	Maximum number of optimisation iterations.
beta	Numeric vector of regression coefficients associated with the time-varying covariate design matrix ('des*' columns).
ae0	be0, ce0 Baseline hazard parameters. * For **2-parameter** baselines, only 'ae0' and 'be0' are used. * For **3-parameter** baselines, all three are used. These parameters are passed directly to the user-supplied baseline cumulative hazard function 'chfun()'.
chfun	A function computing the **baseline cumulative hazard**: * 2-parameter case: 'chfun(time, ae0, be0)' * 3-parameter case: 'chfun(time, ae0, be0, ce0)' The function must return a vector of values of equal length to 'time'.

Details

Likelihood formulation

For each individual \(i\), let \(t_i1 < t_i2 < \cdots < t_iK_i\) denote the *observation / measurement times*.

The cumulative hazard contribution over interval \((t_ij-1, t_ij)\) is:

$$\Delta H_{ij} = [H_0(t_{ij}) - H_0(t_{ij-1})] \exp(x_{ij}^\top \beta),$$

where \(x_ij\) is the vector of covariates measured at time \(t_ij\).

The full log-likelihood is:

$$\ell = \sum_i \left(- \sum_j \Delta H_{ij} + \delta_i \log \left[h_0(T_i) \exp(x_{iK}^\top \beta) \right] \right),$$

where:

* \(\Delta H_ij\) comes from cumulative hazard increments * \(T_i = t_iK\) is the final event or censoring time * \(\delta_i\) is the event indicator * hazard and cumulative hazard are computed from 'chfun()'

The function internally: 1. Splits the data by ID 2. Computes cumulative hazard at all measurement times 3. Computes increments \(\Delta H_ij\) for each ID 4. Constructs the likelihood 5. Optimises over \(\beta\) and baseline parameters

Value

A list containing:

* The full output from ‘optim()‘ or ‘nlminb()‘ * The **negative log-likelihood function** used for optimisation * A vector giving, for each ID, the cumulative hazard increments used in the likelihood

Returned invisibly where appropriate.

Data structure

The input data frame must contain:

* varying number of rows per ID * strictly increasing ‘time‘ within each ID * last row containing the event/censoring time

Covariates must be named as ‘des1‘, ‘des2‘, etc.

`hpgw` *Power Generalised Weibull (PGW) hazard function. http://rpubs.com/FJRubio/PGW*

Description

Power Generalised Weibull (PGW) hazard function. http://rpubs.com/FJRubio/PGW

Usage

```
hpgw(t, sigma, nu, gamma, log = FALSE)
```

Arguments

`t`	: positive argument
`sigma`	: scale parameter
`nu`	: shape parameter
`gamma`	: shape parameter
`log:`	log scale (TRUE or FALSE)

Value

the value of the PGW hazard function

hweibull — *Weibull (W) hazard function.*

Description

Weibull (W) hazard function.

Usage

```
hweibull(t, sigma, nu, log = FALSE)
```

Arguments

t	: positive argument
sigma	: scale parameter
nu	: shape parameter
log:	log scale (TRUE or FALSE)

Value

the value of the Weibull hazard function

pggamma — *Generalised Gamma (GG) cumulative distribution function. https://rpubs.com/FJRubio/GG*

Description

Generalised Gamma (GG) cumulative distribution function. https://rpubs.com/FJRubio/GG

Usage

```
pggamma(t, sigma, nu, gamma, log.p = FALSE)
```

Arguments

t	: positive argument
sigma	: scale parameter
nu	: shape parameter
gamma	: shape parameter
log.p:	log scale (TRUE or FALSE)

Value

the value of the GG cumulative distribution function

qew *Power Exponentiated Weibull (EW) quantile function. https://rpubs.com/FJRubio/EWD*

Description

Power Exponentiated Weibull (EW) quantile function. https://rpubs.com/FJRubio/EWD

Usage

```
qew(p, sigma, nu, gamma)
```

Arguments

p	: probability. A value in (0,1)
sigma	: scale parameter
nu	: shape parameter
gamma	: shape parameter

Value

the value of the EW quantile function

qggamma *Generalised Gamma (GG) quantile function. https://rpubs.com/FJRubio/GG*

Description

Generalised Gamma (GG) quantile function. https://rpubs.com/FJRubio/GG

Usage

```
qggamma(p, sigma, nu, gamma)
```

Arguments

p	: probability. A value in (0,1)
sigma	: scale parameter
nu	: shape parameter
gamma	: shape parameter

Value

the value of the GG quantile function

qllogis *Log-logistic (LL) quantile function.*

Description

Log-logistic (LL) quantile function.

Usage

```
qllogis(p, mu, sigma)
```

Arguments

p	: probability. A value in (0,1)
mu	: mean parameter in the log scale
sigma	: scale parameter in the log scale

Value

the value of the LL quantile function

qpgw *Power Generalised Weibull (PGW) quantile function. http://rpubs.com/FJRubio/PGW*

Description

Power Generalised Weibull (PGW) quantile function. http://rpubs.com/FJRubio/PGW

Usage

```
qpgw(p, sigma, nu, gamma)
```

Arguments

p	: probability. A value in (0,1)
sigma	: scale parameter
nu	: shape parameter
gamma	: shape parameter

Value

the value of the PGW quantile function

`rggamma` *Generalised Gamma (GG) random number generation. https://rpubs.com/FJRubio/GG*

Description

Generalised Gamma (GG) random number generation. https://rpubs.com/FJRubio/GG

Usage

```
rggamma(n, sigma, nu, gamma)
```

Arguments

`n`	: number of observations
`sigma`	: scale parameter
`nu`	: shape parameter
`gamma`	: shape parameter

Value

generates random deviates

`rpgw` *Power Generalised Weibull (PGW) random number generation. http://rpubs.com/FJRubio/PGW*

Description

Power Generalised Weibull (PGW) random number generation. http://rpubs.com/FJRubio/PGW

Usage

```
rpgw(n, sigma, nu, gamma)
```

Arguments

`n`	: number of observations
`sigma`	: scale parameter
`nu`	: shape parameter
`gamma`	: shape parameter

Value

generates random deviates

sggamma *Generalised Gamma (GG) survival function. https://rpubs.com/FJRubio/GG*

Description

Generalised Gamma (GG) survival function. https://rpubs.com/FJRubio/GG

Usage

```
sggamma(t, sigma, nu, gamma, log.p = FALSE)
```

Arguments

t	: positive argument
sigma	: scale parameter
nu	: shape parameter
gamma	: shape parameter
log.p:	log scale (TRUE or FALSE)

Value

the value of the GG survival function

simGH *simGH function: Function to simulate times to event from a model with a GH structure for different parametric baseline hazards. Distributions: LogNormal, LogLogistic, GenGamma, Gamma, Weibull, PGW, EW. See: https://github.com/FJRubio67/HazReg*

Description

simGH function: Function to simulate times to event from a model with a GH structure for different parametric baseline hazards. Distributions: LogNormal, LogLogistic, GenGamma, Gamma, Weibull, PGW, EW. See: https://github.com/FJRubio67/HazReg

Usage

```
simGH(
  seed,
  n,
  des = NULL,
  des_h = NULL,
  des_t = NULL,
  theta,
  beta_h = NULL,
  beta_t = NULL,
  beta = NULL,
  hstr,
  baseline
)
```

Arguments

seed	: seed for simulation
n	: sample size (number of individuals)
des	: Design matrix for AFT, PH, and AH models
des_h	: Design matrix for GH model (hazard scale)
des_t	: Design matrix for GH model (time scale)
theta	: parameters of the baseline hazard
beta_h	: regression parameters multiplying the hazard for GH model
beta_t	: regression parameters multiplying the time scale for GH model
beta	: regression parameters for AFT, PH, and AH models
hstr	: hazard structure (AH, AFT, PH, GH)
baseline	: baseline hazard distribution

Value

a vector containing the simulated times to event

---

spgw *Power Generalised Weibull (PGW) survival function. http://rpubs.com/FJRubio/PGW*

Description

Power Generalised Weibull (PGW) survival function. http://rpubs.com/FJRubio/PGW

Usage

```
spgw(t, sigma, nu, gamma, log.p = FALSE)
```

Arguments

t	: positive argument
sigma	: scale parameter
nu	: shape parameter
gamma	: shape parameter
log.p:	log scale (TRUE or FALSE)

Value

the value of the PGW survival function

SPred_TVC *Compute the Survival Function for a Proportional Hazards or Accelerated Failure Model (2- and 3-parameter baseline)*

Description

Computes the survival function $exp(-H(t \mid x(t)))$ at the last time point for each individual under a proportional hazards (PH) model or Accelerated Failure Time (AFT) model with a two-parameter or three-parameter parametric baseline hazard.

Usage

```
SPred_TVC(df, beta, npar, ae0, be0, ce0 = NULL, chfun, hstr)
```

Arguments

df	A data frame containing: • 'time': numeric vector of time points. • Covariate columns named with prefix '"des"' (e.g., 'des1', 'des2', ...), representing $x(t)$.
beta	Numeric vector of regression coefficients.
npar	Number of parameters in the baseline hazard (2 or 3).
ae0, be0, ce0	Numeric baseline parameters of the cumulative hazard.
chfun	A function computing the baseline cumulative hazard: 'chfun(time, ae0, be0, ce0)'.
hstr	Hazard structure ("PH" or "AFT")

Details

The PH model assumes

$$H(t \mid x(t)) = H_0(t; a_0, b_0, c_0) \exp(x(t)^\top \beta).$$

In the AFT model, event time is rescaled as

$$H(t \mid x(t)) = H_0(t \exp(x(t)^\top \beta); a_0, b_0, c_0).$$

Value

A numeric vector with the survival function evaluated at the last time point in 'df'.

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