

Package ‘SLCARE’

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Type Package

Title Semiparametric Latent Class Analysis for Recurrent Event

Version 1.0.0

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Description An easy-to-use tool for latent class analysis for recurrent events. The modeling framework is based on the semiparametric multiplicative modeling in Zhao et al. (2022) <[doi:10.1111/rssb.12499](https://doi.org/10.1111/rssb.12499)>. Our package provides an alternative method to define initial values in the estimation algorithm based on a joint frailty scale-change model described in Wang et al. (2001) <[doi:10.1198/016214501753209031](https://doi.org/10.1198/016214501753209031)> and K-means. Users are also allowed to specify different initial values by themselves. Our package also provides an alternative algorithm to solving the estimating equation for unobservable latent class membership by fitting a “pseudo” weighted multinomial regression which speeds up the rate of convergence.

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Encoding UTF-8

LazyData true

URL <https://github.com/qyxxx/SLCARE>, <http://www.metaknight.us/SLCARE/>

BugReports <https://github.com/qyxxx/SLCARE/issues>

Imports dplyr, tidyr, ggplot2, reReg, nnet

RoxygenNote 7.2.3

Suggests knitr, rmarkdown

NeedsCompilation no

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Depends R (>= 3.5.0)

Repository CRAN

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entropy	<i>Calculate relative entropy</i>
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Description

Calculate relative entropy for the selection of individual frailty and number of latent classes

Usage

```
entropy(alpha, beta, d, Z, mu_censor, gamma = 0)
```

Arguments

alpha	regression coefficient for multinomial logistic regression model
beta	class specific parameters for recurrent model
d	a vector of observed recurrent events for subjects of interest
Z	a vector of time-independent corvariates
mu_censor	a vector of estimated $\mu(C)$, where C is a vector of censoring time
gamma	individual frailty. 0 represents the frailty equals 1 and k represents the frailty follows $\text{gamma}(k,k)$

Value

a numerical number which measures relative entropy

get_initial	<i>Obtain initial values for estimation procedure.</i>
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Description

Obtain initial value for alpha by: 1. assign class membership to all subjects with Kmeans, then fit the multinomial regression to obtain alpha. Obtain initial value for beta by fitting the multiplicative intensity model studies by Wang et al. (2001) using the reReg() function, stratified by the latent class membership assigned by Kmeans.

Usage

```
get_initial(dat, K)
```

Arguments

dat	a data frame containing the data in the model
K	number of latent classes

Value

A list containing the following components:

ini_alpha	A matrix of initial alpha
ini_beta	A matrix of initial beta

mu_t	<i>estimate mu(t)</i>
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Description

Estimate μ_0 with the Nelson-Aalen type estimator under the assumed multiplicative intensity modeling of recurrent events

Usage

```
mu_t(time_long, censor_long, t)
```

Arguments

time_long	long format time - events (excluding censoring time)
censor_long	long format censoring time (longest follow up time)
t	time of interest

Value

estimated $\mu(t)$

PreprocessData	<i>data pre-processing</i>
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Description

pre-process data into long and wide formats that fit functions in this R package

Usage

```
PreprocessData(dat = dat)
```

Arguments

dat a data frame containing the data in the model

Value

A list containing the following components:

id_wide	A vector of subjects ID in wide format
d	A vector of observed recurrent events for subjects of interest
Z	A vector of time-independent corvariates in wide format
sensor_wide	A vector of censoring time (longest follow up time) in wide format
id_long	A vector of subjects ID in long format
time_long	A vector of long format time for events (excluding censoring time)
sensor_long	A vector of censoring time (longest follow up time) in long format
Z_long	A vector of time-independent corvariates in long format

p_D	<i>Estimate $P(D xi, Z, C)$</i>
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Description

Estimate $P(D_i = d_i \mid x_i = k, Z_i, C_i)$

Usage

```
p_D(d, beta, Z, mu_censor, gamma = 0)
```

Arguments

d a vector of observed recurrent events for subjects of interest

beta class specific parameters for recurrent model

Z a vector of time-independent covariates

mu_censor a vector of estimated $\mu(C)$, where C is a vector of censoring time

gamma individual frailty. 0 represents the frailty equals 1 and k represents the frailty follows $\text{gamma}(k,k)$

Value

a vector of estimated $P(D_{i_di} \mid x_i = k, Z_i, C_i)$

p_xi	<i>Estimate $P(x_i \mid Z, C)$</i>
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Description

estimate $P(x_i = k \mid Z_i, C_i)$

Usage

```
p_xi(alpha, Z)
```

Arguments

alpha regression coefficient for multinomial logistic regression model (xi)

Z a vector of time-independent covariates

Value

a vector of estimated $P(x_i = k \mid Z_i, C_i)$

Description

Conduct Semiparametric Latent Class Analysis for Recurrent Event.

Usage

```
SLCARE(
  alpha = NULL,
  beta = NULL,
  dat,
  K = NULL,
  gamma = 0,
  max_epochs = 500,
  conv_threshold = 0.01,
  boot = NULL
)
```

Arguments

alpha	initial values for alpha for estimation procedure. This should be NULL or a numeric matrix. NULL means obtain initial value with k-means.
beta	initial value for beta for estimation procedure. This should be NULL or a numeric matrix. NULL means obtain initial value with k-means.
dat	a data frame containing the data in the model
K	number of latent classes
gamma	individual frailty. 0 represents the frailty equals 1 and k represents the frailty follows gamma(k,k)
max_epochs	maximum iteration epochs for estimation procedure
conv_threshold	converge threshold for estimation procedure
boot	bootstrap sample size

Value

A list containing the following components:

alpha Point estimates for alpha

beta Point estimates for beta

convergeLoss Converge loss in estimation procedure

PosteriorPrediction Posterior prediction for observed events for subjects of interest

EstimatedTau Posterior probability of latent class membership

ModelChecking Plot for model checking

Estimated_mu0t Plot for estimated $\mu_0(t)$

est_mu0() A function allows to calculate $\mu_0(t)$ for specific time points

Estimated_Mean_Function Plot of estimated mean functions

RelativeEntropy Relative entropy

InitialAlpha Initial alpha for estimation procedure

InitialBeta Initial beta for estimation procedure

If argument 'boot' is non-NULL, then SLCARE returns two additional components:

alpha_bootse Bootstrap standard error for alpha

beta_bootse Bootstrap standard error for beta

Examples

```
data(SLCARE_simdat)
# Example 1: number of latent classes k = 2,
# By default, generate initial values in estimation procedure with K-means
model1 <- SLCARE(dat = SLCARE_simdat, K=2)
# contents of output
names(model1)
# point estimates
model1$alpha
model1$beta
# converge loss in estimation procedure
model1$convergeLoss
# Posterior prediction
model1$PosteriorPrediction
# Posterior probability of latent class membership
model1$EstimatedTau
# model checking plot
model1$ModelChecking
# Plot of estimated  $\mu_0(t)$  for all observed time
model1$Estimated_mu0t
# Estimated  $\mu_0(t)$ 
# You may input multiple time points of interest
model1$est_mu0(c(100, 1000, 5000))
# Plot of estimated mean function
model1$Estimated_Mean_Function
# Relative entropy
model1$RelativeEntropy
# Initial values for estimation procedure
model1$InitialAlpha
model1$InitialBeta
```

SLCARE_simdat	<i>Simulated dataset</i>
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Description

A dataset simulated from a real world dataset

id subjects identification

time time recored including event and longest followup time (censoring)

event recurrent event indicator; 1 if a recurrent event is recorded

x1 a dummy baseline covariate

x2 a continuous baseline covariate range from 0 to 1

Usage

```
data(SLCARE_simdat)
```

Format

A data frame with 478 rows and 5 variables.

SLCA_predict	<i>Posterior prediction for model checking</i>
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Description

Predict numbers of recurrent events.

Usage

```
SLCA_predict(alpha, beta, d, Z, mu_censor, gamma = 0)
```

Arguments

alpha	estimated alpha - multinomial regression coefficients for latent class membership
beta	estimated beta - class
d	a vector of observed recurrent events for subjects of interest
Z	a vector of time-independent corvariates
mu_censor	a vector of estimated $\mu(C)$, where C is a vector of censoring time
gamma	individual frailty. 0 represents the frailty equals 1 and k represents the frailty follows $\text{gamma}(k,k)$

Value

A list containing the following components:

PosteriorPredict	A vector of posterior prediction for observed events for subjects of interest
tauhat	A matrix of posterior probability of latent class membership

update_alpha	<i>Estimation algorithm - updating alpha</i>
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Description

Updating alpha in estimation procedure. Updating alpha by fitting a weighted multinomial regression.

Usage

```
update_alpha(alpha, beta, d, Z, mu_censor, gamma = 0)
```

Arguments

alpha	a matrix of alpha before updating - regression coefficient for multinomial logistic regression model
beta	a matrix of beta before updating - class specific parameters for recurrent model
d	a vector of observed recurrent events for subjects of interest
Z	a vector of time-independent corvariates
mu_censor	a vector of estimated $\mu(C)$, where C is a vector of censoring time
gamma	individual frailty. 0 represents the frailty equals 1 and k represents the frailty follows $\text{gamma}(k,k)$

Value

a matrix of updated alpha - regression coefficient for multinomial logistic regression model

update_beta	<i>Estimation algorithm - updating beta</i>
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Description

Updating beta in estimation procedure. Updating beta by fitting "pseudo" weighted Poisson regression model

Usage

```
update_beta(alpha, beta, d, Z, mu_censor, gamma = 0)
```

Arguments

alpha	a matrix of alpha before updating - regression coefficient for multinomial logistic regression model
beta	a matrix of beta before updating - class specific parameters for recurrent model
d	a vector of observed recurrent events for subjects of interest
Z	a vector of time-independent covariates
mu_censor	a vector of estimated $\mu(C)$, where C is a vector of censoring time
gamma	individual frailty. 0 represents the frailty equals 1 and k represents the frailty follows $\text{gamma}(k,k)$

Value

a matrix of updated beta - class specific parameters for recurrent model

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