Package ‘intccr’

October 13, 2022

Type Package

Title Semiparametric Competing Risks Regression under Interval Censoring

Version 3.0.4

Author Giorgos Bakoyannis <gbakogia@iu.edu>, Jun Park <jun.park@alumni.iu.edu>

Maintainer Jun Park <jun.park@alumni.iu.edu>

Description Semiparametric regression models on the cumulative incidence function for interval-censored competing risks data as described in Bakoyannis, Yu, & Yiannoutsos (2017) \doi{10.1002/sim.7350} and the models with missing event types as described in Park, Bakoyannis, Zhang, & Yiannoutsos (2021) \doi{10.1093/biostatistics/kxaa052}. The proportional subdistribution hazards model (Fine-Gray model), the proportional odds model, and other models that belong to the class of semiparametric generalized odds rate transformation models.

Date 2022-05-09

Imports alabama, doParallel, foreach, MASS, parallel, splines2, stats, utils

Suggests R.rsp

Depends R (>= 3.5.0)

License GPL (>= 2)

Encoding UTF-8

LazyData true

RoxygenNote 7.1.2

VignetteBuilder R.rsp

NeedsCompilation no

Repository CRAN

Date/Publication 2022-05-10 08:00:02 UTC
R topics documented:

<table>
<thead>
<tr>
<th>Function</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>bs.derivs</td>
<td>3</td>
</tr>
<tr>
<td>bssmle</td>
<td>4</td>
</tr>
<tr>
<td>bssmle_aipw</td>
<td>5</td>
</tr>
<tr>
<td>bssmle_lse</td>
<td>6</td>
</tr>
<tr>
<td>bssmle_lse_lt</td>
<td>7</td>
</tr>
<tr>
<td>bssmle_lt</td>
<td>8</td>
</tr>
<tr>
<td>bssmle_se</td>
<td>9</td>
</tr>
<tr>
<td>bssmle_se_aipw</td>
<td>10</td>
</tr>
<tr>
<td>ciregic</td>
<td>11</td>
</tr>
<tr>
<td>ciregic_aipw</td>
<td>14</td>
</tr>
<tr>
<td>ciregic_lt</td>
<td>17</td>
</tr>
<tr>
<td>dataprep</td>
<td>19</td>
</tr>
<tr>
<td>dataprep_lt</td>
<td>21</td>
</tr>
<tr>
<td>dbs</td>
<td>22</td>
</tr>
<tr>
<td>fit</td>
<td>23</td>
</tr>
<tr>
<td>fit_aipw</td>
<td>23</td>
</tr>
<tr>
<td>fit_lt</td>
<td>24</td>
</tr>
<tr>
<td>longdata</td>
<td>24</td>
</tr>
<tr>
<td>longdata_lt</td>
<td>25</td>
</tr>
<tr>
<td>naive_b</td>
<td>25</td>
</tr>
<tr>
<td>predict.ciregic</td>
<td>26</td>
</tr>
<tr>
<td>predict.ciregic_aipw</td>
<td>27</td>
</tr>
<tr>
<td>predict.ciregic_lt</td>
<td>28</td>
</tr>
<tr>
<td>predict.dbs</td>
<td>29</td>
</tr>
<tr>
<td>pseudo.HIV.long</td>
<td>30</td>
</tr>
<tr>
<td>simdata</td>
<td>31</td>
</tr>
<tr>
<td>simdata_aipw</td>
<td>31</td>
</tr>
<tr>
<td>simdata_lt</td>
<td>32</td>
</tr>
<tr>
<td>summary.ciregic</td>
<td>33</td>
</tr>
<tr>
<td>summary.ciregic_aipw</td>
<td>34</td>
</tr>
<tr>
<td>summary.ciregic_lt</td>
<td>35</td>
</tr>
<tr>
<td>Surv2</td>
<td>36</td>
</tr>
<tr>
<td>vcov.ciregic</td>
<td>37</td>
</tr>
<tr>
<td>vcov.ciregic_aipw</td>
<td>38</td>
</tr>
<tr>
<td>vcov.ciregic_LT</td>
<td>39</td>
</tr>
<tr>
<td>vcov.summary.ciregic</td>
<td>40</td>
</tr>
<tr>
<td>vcov.summary.ciregic_aipw</td>
<td>41</td>
</tr>
<tr>
<td>vcov.summary.ciregic_lt</td>
<td>42</td>
</tr>
<tr>
<td>waldtest</td>
<td>43</td>
</tr>
</tbody>
</table>

Index 45
**bs.derivs**  
*Derivative of B-spline*

**Description**
Generates the derivative of the B-splines basis matrix.

**Usage**
```r
bs.derivs(
  x, 
  derivs = 0, 
  df = NULL, 
  knots = NULL, 
  degree = 3, 
  intercept = FALSE, 
  Boundary.knots = range(x)
)
```

**Arguments**
- `x`: object of B-splines
- `derivs`: a number of derivatives
- `df`: degrees of freedom of B-splines
- `knots`: a vector of internal knots
- `degree`: degrees of B-splines
- `intercept`: a logical vector
- `Boundary.knots`: a vector of boundary knots

**Details**
The function `bs.derivs` performs derivatives of B-splines

**Value**
The function `bs.derivs` returns a component:

- `resmat`: derivatives of B-spline

**Author(s)**
- Jun Park, <jp84@alumni.iu.edu>
- Giorgos Bakoyannis, <gbakogia@iu.edu>
**bssmle**  
*B-spline Sieve Maximum Likelihood Estimation*

**Description**
Routine that performs B-spline sieve maximum likelihood estimation with linear and nonlinear inequality/equality constraints

**Usage**

```r
bssmle(formula, data, alpha, k = 1)
```

**Arguments**

- `formula`  
a formula object relating survival object `Surv2(v, u, event)` to a set of covariates
- `data`  
a data frame that includes the variables named in the formula argument
- `alpha`  
\( \alpha = (\alpha_1, \alpha_2) \) contains parameters that define the link functions from class of generalized odds-rate transformation models. The components \( \alpha_1 \) and \( \alpha_2 \) should both be \( \geq 0 \). If \( \alpha_1 = 0 \), the user assumes the proportional subdistribution hazards model or the Fine-Gray model for the cause of failure 1. If \( \alpha_2 = 1 \), the user assumes the proportional odds model for the cause of failure 2.
- `k`  
a parameter that controls the number of knots in the B-spline with \( 0.5 \leq k \leq 1 \)

**Details**
The function `bssmle` performs B-spline sieve maximum likelihood estimation.

**Value**
The function `bssmle` returns a list of components:

- `beta`  
a vector of the estimated coefficients for the B-splines
- `varnames`  
a vector containing variable names
- `alpha`  
a vector of the link function parameters
- `loglikelihood`  
a loglikelihood of the fitted model
- `convergence`  
an indicator of convergence
- `tms`  
a vector of the minimum and maximum observation times
- `Z`  
a set of covariates
- `Tv`  
a vector of \( v \)
- `Tu`  
a vector of \( u \)
- `Bv`  
a list containing the B-splines basis functions evaluated at \( v \)
- `Bu`  
a list containing the B-splines basis functions evaluated at \( v \)
**bssmle_aipw**

- **dBv** a list containing the first derivative of the B-splines basis functions evaluated at \( v \)
- **dBu** a list containing the first derivative of the B-splines basis functions evaluated at \( u \)
- **dmat** a matrix of event indicator functions

**Author(s)**

Giorgos Bakoyannis, <gbakogia@iu.edu>

Jun Park, <jun.park@alumni.iu.edu>

---

**bssmle_aipw**

*B-spline Sieve Maximum Likelihood Estimation for Interval-Censored Competing Risks Data and Missing Cause of Failure*

---

**Description**

Routine that performs B-spline sieve maximum likelihood estimation with linear and nonlinear inequality and equality constraints

**Usage**

```r
bssmle_aipw(formula, aux, data, alpha, k)
```

**Arguments**

- **formula** a formula object relating survival object `Surv2(v, u, event)` to a set of covariates
- **aux** auxiliary variables that may be associated with the missingness and the outcome of interest
- **data** a data frame that includes the variables named in the formula argument
- **alpha** \( \alpha = (\alpha_1, \alpha_2) \) contains parameters that define the link functions from class of generalized odds-rate transformation models. The components \( \alpha_1 \) and \( \alpha_2 \) should both be \( \geq 0 \). If \( \alpha_1 = 0 \), the user assumes the proportional subdistribution hazards model or the Fine-Gray model for the event type 1. If \( \alpha_2 = 1 \), the user assumes the proportional odds model for the event type 2.
- **k** a parameter that controls the number of knots in the B-spline with \( 0.5 \leq k \leq 1 \)

**Details**

The function `bssmle_aipw` performs B-spline sieve maximum likelihood estimation.
Value

The function `bssmle_lse` returns a list of components:

- **beta**: a vector of the estimated coefficients for the B-splines
- **varnames**: a vector containing variable names
- **varnames.aux**: a vector containing auxiliary variable names
- **alpha**: a vector of the link function parameters
- **loglikelihood**: a loglikelihood of the fitted model
- **convergence**: an indicator of convergence
- **tms**: a vector of the minimum and maximum observation times
- **Bv**: a list containing the B-splines basis functions evaluated at v

Author(s)

Jun Park, <jun.park@alumni.iu.edu>
Giorgos Bakoyannis, <gbakogia@iu.edu>

---

**bssmle_lse**  
*Least-Squares Estimator of the Information Matrix*

Description

Perform the least-squares methods to estimate the information matrix for the estimated regression coefficients.

Usage

```
bssmle_lse(obj)
```

Arguments

- `obj`: a list of objectives from `bssmle`

Details

The function `bssmle_lse` estimates the information matrix for the estimated regression coefficients from the function `bssmle` using the least-squares method.

Value

The function `bssmle_lse` returns a list of components:

- **Sigma**: the estimated variance-covariance matrix for the estimated regression coefficients
Author(s)
Jun Park, <jun.park@alumni.iu.edu>
Giorgos Bakoyannis, <gbakogia@iu.edu>

References

bssmle_lse_lt

Description
Performs the least-squares methods to estimate the information matrix for the estimated regression coefficients

Usage
bssmle_lse_lt(obj)

Arguments
obj a list of objectives from bssmle_lt

Details
The function bssmle_lse_lt estimates the information matrix for the estimated regression coefficients from the function bssmle_lt using the lease-squares method.

Value
The function bssmle_lse_lt returns a list of components:
Sigma the estimated information matrix for the estimated regression coefficients

Author(s)
Jun Park, <jun.park@alumni.iu.edu>
Giorgos Bakoyannis, <gbakogia@iu.edu>

References
bssmle_lt

B-spline Sieve Maximum Likelihood Estimation for Left-Truncated and Interval-Censored Competing Risks Data

Description
Routine that performs B-spline sieve maximum likelihood estimation with linear and nonlinear inequality/equality constraints

Usage
bssmle_lt(formula, data, alpha, k = 1)

Arguments
formula a formula object relating survival object Surv2(w, v, u, event) to a set of covariates
data a data frame that includes the variables named in the formula argument
alpha \(\alpha = (\alpha_1, \alpha_2)\) contains parameters that define the link functions from class of generalized odds-rate transformation models. The components \(\alpha_1\) and \(\alpha_2\) should both be \(\geq 0\). If \(\alpha_1 = 0\), the user assumes the proportional subdistribution hazards model or the Fine-Gray model for the event type 1. If \(\alpha_2 = 1\), the user assumes the proportional odds model for the event type 2.
k a parameter that controls the number of knots in the B-spline with \(0.5 \leq k \leq 1\)

Details
The function bssmle_lt performs B-spline sieve maximum likelihood estimation for left-truncated and interval-censored competing risks data.

Value
The function bssmle_lt returns a list of components:

beta a vector of the estimated coefficients
varnames a vector containing variable names
alpha a vector of the link function parameters
loglikelihood a loglikelihood of the fitted model
convergence an indicator of convergence
tms a vector of the minimum and maximum observation times
Z a design matrix
Tw a vector of \(w\)
Tv a vector of \(v\)
Tu a vector of \(u\)
bssmle_se

Bw  a list containing the B-splines basis functions evaluated at w
Bv  a list containing the B-splines basis functions evaluated at v
Bu  a list containing the B-splines basis functions evaluated at u
dBw a list containing the first derivative of the B-splines basis functions evaluated at w
dBv a list containing the first derivative of the B-splines basis functions evaluated at v
dBu a list containing the first derivative of the B-splines basis functions evaluated at u
dmat a matrix of event indicator functions

Author(s)

Jun Park, <jun.park@alumni.iu.edu>
Giorgos Bakoyannis, <gbakogia@iu.edu>

Description

Bootstrap variance-covariance estimation

Usage

bssmle_se(formula, data, alpha, k = 1, do.par, nboot, objfun)

Arguments

formula  a formula object relating survival object Surv2(v, u, event) to a set of covariates
data  a data frame that includes the variables named in the formula argument
alpha  \(\alpha = (\alpha_1, \alpha_2)\) contains parameters that define the link functions from class of generalized odds-rate transformation models. The components \(\alpha_1\) and \(\alpha_2\) should both be \(\geq 0\). If \(\alpha_1 = 0\), the user assumes the proportional subdistribution hazards model or the Fine-Gray model for the cause of failure 1. If \(\alpha_2 = 1\), the user assumes the proportional odds model for the cause of failure 2.
k  a parameter that controls the number of knots in the B-spline with \(0.5 \leq k \leq 1\)
do.par  using parallel computing for bootstrap calculation. If do.par = TRUE, parallel computing will be used during the bootstrap estimation of the variance-covariance matrix for the regression parameter estimates.
nboot  a number of bootstrap samples for estimating variances and covariances of the estimated regression coefficients. If nboot = 0, the function ciregic does not perform bootstrap estimation of the variance matrix of the regression parameter estimates and returns NA in the place of the estimated variance matrix of the regression parameter estimates.
objfun  an option to select estimating function
Details
The function `bssmle_se` estimates bootstrap standard errors for the estimated regression coefficients from the function `bssmle`, `bssmle_lt`, `robssmle_ltir`.

Value
The function `bssmle_se` returns a list of components:

- `notconverged`: a list of number of bootstrap samples that did not converge
- `numboot`: a number of bootstrap converged
- `Sigma`: an estimated bootstrap variance-covariance matrix of the estimated regression coefficients

Author(s)
Giorgos Bakoyannis, <gbakogia@iu.edu>
Jun Park, <jun.park@alumni.iu.edu>

---

**bssmle_se_aipw**

*Bootstrap variance-covariance estimation for interval-censored competing risks data and missing cause of failure*

Description
Bootstrap variance estimation for the estimated regression coefficients

Usage

```r
bssmle_se_aipw(formula, aux, data, alpha, k, do.par, nboot, w.cores = NULL)
```

Arguments

- `formula`: a formula object relating survival object `mSurv(v, u, event)` to a set of covariates
- `aux`: auxiliary variables that may be associated with the missingness and the outcome of interest
- `data`: a data frame that includes the variables named in the formula argument
- `alpha`: \( \alpha = (\alpha_1, \alpha_2) \) contains parameters that define the link functions from class of generalized odds-rate transformation models. The components \( \alpha_1 \) and \( \alpha_2 \) should both be \( \geq 0 \). If \( \alpha_1 = 0 \), the user assumes the proportional subdistribution hazards model or the Fine-Gray model for the event type 1. If \( \alpha_2 = 1 \), the user assumes the proportional odds model for the event type 2.
- `k`: a parameter that controls the number of knots in the B-spline with \( 0.5 \leq k \leq 1 \)
do.par: using parallel computing for bootstrap calculation. If do.par = TRUE, parallel computing will be used during the bootstrap estimation of the variance-covariance matrix for the regression parameter estimates.

nboot: a number of bootstrap samples for estimating variances and covariances of the estimated regression coefficients. If nboot = 0, the function ciregic does not perform bootstrap estimation of the variance matrix of the regression parameter estimates and returns NA in the place of the estimated variance matrix of the regression parameter estimates.

w.cores: a number of cores that are assigned (the default is NULL)

Details

The function bssmle_aipw_se estimates bootstrap standard errors for the estimated regression coefficients from the function bssmle.

Value

The function bssmle_aipw_se returns a list of components:

notconverged: a list of number of bootstrap samples that did not converge
numboot: a number of bootstrap converged
Sigma: an estimated bootstrap variance-covariance matrix of the estimated regression coefficients

Author(s)

Jun Park, <jun.park@alumni.iu.edu>
Giorgos Bakoyannis, <gbakogia@iu.edu>

description

The function ciregic performs semiparametric regression on cumulative incidence function with interval-censored competing risks data. It fits the proportional subdistribution hazards model (Fine-Gray model), the proportional odds model, and other models that belong to the class of semiparametric generalized odds rate transformation models. The standard errors for the estimated regression coefficients are estimated by a choice of options: 1) the bootstrapping method or 2) the least-squares method.

Usage

ciregic(formula, data, alpha, k = 1, do.par, nboot, ...)

Arguments

formula  
a formula object relating the survival object Surv2(v, u, event) to a set of covariates

data  
a data frame that includes the variables named in the formula argument

alpha  
α = (α1, α2) contains parameters that define the link functions from class of generalized odds-rate transformation models. The components α1 and α2 should both be ≥ 0. If α1 = 0, the user assumes the proportional subdistribution hazards model or the Fine-Gray model for the cause of failure 1. If α2 = 1, the user assumes the proportional odds model for the cause of failure 2.

k  
a parameter that controls the number of knots in the B-spline with 0.5 ≤ k ≤ 1

do.par  
an option to use parallel computing for bootstrap. If do.par = TRUE, parallel computing will be used during the bootstrap estimation of the variance-covariance matrix for the regression parameter estimates.

nboot  
a number of bootstrap samples for estimating variances and covariances of the estimated regression coefficients. If nboot = 0, the function ciregic provides the variance estimator of the regression parameter estimates using the least-squares method and does not perform the bootstrap method.

...  
further arguments

Details

The formula for the model has the form of response ~ predictors. The response in the formula is a Surv2(v, u, event) object where v is the last observation time prior to the failure, u is the first observation time after the failure, and event is the event or censoring indicator. event should include 0, 1 or 2, denoting right-censoring, failure from cause 1 and failure from cause 2, respectively. If event=0 (i.e. right-censored observation) then u is not included in any calculation as it corresponds to ∞. The user can provide any value in u for the right-censored cases, even NA. The function ciregic fits models that belong to the class of generalized odds rate transformation models which includes the proportional subdistribution hazards or the Fine-Gray model and the proportional odds model. The parameter α = (α1, α2) defines the link function/model to be fitted for cause of failure 1 and 2, respectively. A value of 0 corresponds to the Fine-Gray model and a value of 1 corresponds to the proportional odds model. For example, if α = (0, 1) then the function ciregic fits the Fine-Gray model for cause 1 and the proportional odds model for cause 2.

Value

The function ciregic provides an object of class ciregic with components:

varnames  
a vector containing variable names

coefficients  
a vector of the regression coefficient estimates

gamma  
a vector of the estimated coefficients for the B-splines

vcov  
a variance-covariance matrix of the estimated regression coefficients

alpha  
a vector of the link function parameters

loglikelihood  
a loglikelihood of the fitted model

convergence  
an indicator of convergence
tms  a vector of the minimum and maximum observation times
Bv   a list containing the B-splines basis functions evaluated at v
numboot a number of converged bootstrap
notconverged a list of number of bootstrap samples that did not converge
call  a matched call

Author(s)
Giorgos Bakoyannis, <gbakogia@iu.edu>
Jun Park, <jun.park@alumni.iu.edu>

References

See Also
summary.ciregic for the summarized results and predict.ciregic for value of the predicted cumulative incidence functions. coef and vcov are the generic functions. dataprep for reshaping data from a long format to a suitable format to be used in the function ciregic.

Examples
## Not run:
## Set seed in order to have reproducibility of the bootstrap standard error estimate
set.seed(1234)

## Reshaping data from a long format to a suitable format
newdata <- dataprep(data = longdata, ID = id, time = t,
                    event = c, Z = c(z1, z2))

## Estimation of regression parameters only. No bootstrap variance estimation.
## with 'newdata'
fit <- ciregic(formula = Surv2(v = v, u = u, event = c) ~ z1 + z2, data = newdata,
               alpha = c(1, 1), nboot = 0, do.par = FALSE)
fit

## Bootstrap variance estimation based on 50 replications
fit <- ciregic(formula = Surv2(v = v, u = u, event = c) ~ z1 + z2, data = newdata,
               alpha = c(1, 1), nboot = 50, do.par = FALSE)

## End(Not run)
## Note that the user can use parallel computing to decrease
## the computation time of the bootstrap variance-covariance
## estimation (e.g. nboot = 50)
## Summarize semiparametric regression model
summary(fit)

## Predict and draw plot the cumulative incidence function evaluated at z1 = 1 and z2 = 0.5
t <- seq(from = 0, to = 2.8, by = 2.8 / 99)
pred <- predict(object = fit, covp = c(1, 0.5), times = t)
pred
plot(pred$t, pred$cif1, type = "l", ylim = c(0, 1))
points(pred$t, pred$cif2, type = "l", col = 2)

ciregic_aipw

### Competing Risks Regression with Interval-Censored Data and Missing Cause of Failure

**Description**

The function ciregic_aipw performs semiparametric regression on cumulative incidence function with interval-censored competing risks data in the presence of missing cause of failure. It fits the proportional subdistribution hazards model (Fine-Gray model), the proportional odds model, and other models that belong to the class of semiparametric generalized odds rate transformation models. The estimates have double robustness property, which means that the estimators are consistent even if either the model for the probability of missingness or the model for the probability of the cause of failure is misspecified under the missing at random assumption.

**Usage**

```r
ciregic_aipw(
  formula,
  aux = NULL,
  data,
  alpha,
  k = 1,
  do.par,
  nboot,
  w.cores = NULL,
  ...
)
```

**Arguments**

- **formula**: a formula object relating the survival object `Surv2(v, u, event)` to a set of covariates
- **aux**: auxiliary variable(s) that may be associated with the missingness and the outcome of interest
- **data**: a data frame that includes the variables named in the formula argument
alpha \( \alpha = (\alpha_1, \alpha_2) \) contains parameters that define the link functions from class of generalized odds-rate transformation models. The components \( \alpha_1 \) and \( \alpha_2 \) should both be \( \geq 0 \). If \( \alpha_1 = 0 \), the user assumes the proportional subdistribution hazards model or the Fine-Gray model for the event type 1. If \( \alpha_2 = 1 \), the user assumes the proportional odds model for the event type 2.

\( k \) a parameter that controls the number of knots in the B-spline with \( 0.5 \leq k \leq 1 \)

\( \text{do.par} \) an option to use parallel computing for bootstrap. If \( \text{do.par} = \text{TRUE} \), parallel computing will be used during the bootstrap estimation of the variance-covariance matrix for the regression parameter estimates.

\( \text{nboot} \) a number of bootstrap samples for estimating variances and covariances of the estimated regression coefficients. If \( \text{nboot} = 0 \), the function \text{ciregic_aipw} does not perform bootstrap estimation of the variance-covariance matrix of the regression parameter estimates and returns \( \text{NA} \) in the place of the estimated variance-covariance matrix of the regression parameter estimates.

\( \text{w.cores} \) a number of cores that are assigned (the default is \( \text{NULL} \))

... further arguments

Details

The formula for the model has the form of \( \text{response} \sim \text{predictors} \). The response in the formula is a \( \text{Surv2}(v, u, \text{event}) \) object where \( v \) is the last observation time prior to the event, \( u \) is the first observation time after the event, and \( \text{event} \) is the event or censoring indicator. \( \text{event} \) should include 0, 1 or 2, denoting right-censoring, event type 1 and 2, respectively. If \( \text{event}=0 \) (i.e. right-censored observation) then \( u \) is not included in any calculation as it corresponds to \( \infty \). The user can provide any value in \( u \) for the right-censored cases, even \( \text{NA} \). The function \text{ciregic_aipw} fits models that belong to the class of generalized odds rate transformation models which includes the proportional subdistribution hazards or the Fine-Gray model and the proportional odds model. The parameter \( \alpha = (\alpha_1, \alpha_2) \) defines the link function/model to be fitted for event 1 and 2, respectively. A value of 0 corresponds to the Fine-Gray model and a value of 1 corresponds to the proportional odds model. For example, if \( \alpha = (0, 1) \) then the function \text{ciregic_aipw} fits the Fine-Gray model for the event type 1 and the proportional odds model for the event type 2.

Value

The function \text{ciregic_aipw} provides an object of class \text{ciregic_aipw} with components:

\( \text{varnames} \) a vector containing variable names
\( \text{varnames.aux} \) a vector containing auxiliary variable names
\( \text{coefficients} \) a vector of the regression coefficient estimates
\( \text{gamma} \) a vector of the estimated coefficients for the B-splines
\( \text{vcov} \) a variance-covariance matrix of the estimated regression coefficients
\( \text{alpha} \) a vector of the link function parameters
\( \text{loglikelihood} \) a loglikelihood of the fitted model
\( \text{convergence} \) an indicator of convergence
\( \text{tms} \) a vector of the minimum and maximum observation times
Bv  a list containing the B-splines basis functions evaluated at v
numboot  a number of converged bootstrap
notconverged  a list of number of bootstrap samples that did not converge
call  a matched call

Author(s)
Jun Park, <jun.park@alumni.iu.edu>
Giorgos Bakoyannis, <gbakogia@iu.edu>

References


See Also
*summary.ciregic_aipw* for the summarized results and *predict.ciregic_aipw* for value of the predicted cumulative incidence functions. *coef* and *vcov* are the generic functions. *dataprep* function for reshaping data from a long format to a suitable format to be used in the function *ciregic_aipw*.

Examples
```r
## Not run:
# Set seed in order to have reproducibility of the bootstrap standard error estimate
set.seed(1234)

## Estimation of regression parameters only. No bootstrap variance estimation.
## with 'simdata_aipw'
data(simdata_aipw)
fit_aipw <- ciregic_aipw(formula = Surv2(v = v, u = u, event = c) ~ z1 + z2, aux = a,
data = simdata_aipw, alpha = c(1, 1), nboot = 0,
do.par = FALSE)

fit_aipw

## Bootstrap variance estimation based on 50 replications
fit_aipw <- ciregic_aipw(formula = Surv2(v = v, u = u, event = c) ~ z1 + z2, aux = a,
data = simdata_aipw, alpha = c(1, 1), k = 1, nboot = 50,
do.par = FALSE)

## End(Not run)

## Note that the user can use parallel computing to decrease
## the computation time of the bootstrap variance-covariance
## estimation (e.g. nboot = 50)

## Summarize semiparametric regression model
summary(fit_aipw)
```
## Predict and draw plot the cumulative incidence function evaluated at z1 = 1 and z2 = 0.5

t <- seq(from = 0, to = 2.8, by = 2.8 / 99)
pred <- predict(object = fit_aipw, covp = c(1, 0.5), times = t)
pred
plot(pred$t, pred$cif1, type = "l", ylim = c(0, 1))
points(pred$t, pred$cif2, type = "l", col = 2)

---

ciregic_lt

### Competing Risks Regression with Left-truncated and Interval-Censored Data

**Description**

The function `ciregic_lt` performs semiparametric regression on cumulative incidence function with left-truncated and interval-censored competing risks data. It fits the proportional subdistribution hazards model (Fine-Gray model), the proportional odds model, and other models that belong to the class of semiparametric generalized odds rate transformation models. The least-square method is implemented to estimate the standard error of the regression coefficients.

**Usage**

```
ciregic_lt(formula, data, alpha, k = 1, do.par, nboot, ...)  
```

**Arguments**

- `formula` a formula object relating the survival object `Surv2(v, u, w, event)` to a set of covariates
- `data` a data frame that includes the variables named in the formula argument
- `alpha` $\alpha = (\alpha_1, \alpha_2)$ contains parameters that define the link functions from class of generalized odds-rate transformation models. The components $\alpha_1$ and $\alpha_2$ should both be $\geq 0$. If $\alpha_1 = 0$, the user assumes the proportional subdistribution hazards model or the Fine-Gray model for the cause of failure 1. If $\alpha_2 = 1$, the user assumes the proportional odds model for the cause of failure 2.
- `k` a parameter that controls the number of knots in the B-spline with $0.5 \leq k \leq 1$
- `do.par` an option to use parallel computing for bootstrap. If `do.par = TRUE`, parallel computing will be used during the bootstrap estimation of the variance-covariance matrix for the regression parameter estimates.
- `nboot` a number of bootstrap samples for estimating variances and covariances of the estimated regression coefficients. If `nboot = 0`, the function `ciregic_lt` returns a closed-form variance estimator using the least-squares method and does not perform bootstrap estimation of the variance-covariance matrix of the regression parameter estimates. For `nboot \geq 1`, the function `ciregic_lt` returns the bootstrap variance estimator of the regression parameter estimates.
- `...` further arguments
Details

The function `ciregic_lt` is capable of analyzing left-truncated and interval-censored competing risks data. A triplet of time points \((w, v, u)\) is required if an observation is left-truncated and interval-censored. A part of left-truncation is also allowed by defining \(w = 0\) for interval-censored only observation. The formula for the model has the form of \(\text{response} \sim \text{predictors}\). The response in the formula is a \(\text{Surv2}(v, u, w, \text{event})\) object where \(w\) is a left-truncation time, \(v\) is the last observation time prior to the failure, \(u\) is the first observation time after the failure, and \(\text{event}\) is the event or censoring indicator. \(\text{event}\) should include 0, 1 or 2, denoting right-censoring, failure from cause 1 and failure from cause 2, respectively. If \(\text{event}=0\) (i.e. right-censored observation) then \(u\) is not included in any calculation as it corresponds to \(\infty\). The user can provide any value in \(u\) for the right-censored cases, even NA. The function `ciregic_lt` fits models that belong to the class of generalized odds rate transformation models which includes the proportional subdistribution hazards or the Fine-Gray model and the proportional odds model. The parameter \(\alpha = (\alpha_1, \alpha_2)\) defines the link function/model to be fitted for cause 1 and 2, respectively. A value of 0 corresponds to the Fine-Gray model and a value of 1 corresponds to the proportional odds model. For example, if \(\alpha = (0, 1)\) then the function `ciregic_lt` fits the Fine-Gray model for cause 1 and the proportional odds model for cause 2.

Value

The function `ciregic_lt` provides an object of class `ciregic_lt` with components:

- `varnames` a vector containing variable names
- `coefficients` a vector of the regression coefficient estimates
- `gamma` a vector of the estimated coefficients for the B-splines
- `vcov` a variance-covariance matrix of the estimated regression coefficients
- `alpha` a vector of the link function parameters
- `loglikelihood` a loglikelihood of the fitted model
- `convergence` an indicator of convergence
- `tms` a vector of the minimum and maximum observation times
- `Bv` a list containing the B-splines basis functions evaluated at \(v\)
- `numboot` a number of converged bootstrap
- `notconverged` a list of number of bootstrap samples that did not converge
- `call` a matched call

Author(s)

Jun Park, <jun.park@alumni.iu.edu>
Giorgos Bakoyannis, <gbakogia@iu.edu>

References


See Also

`summary.ciregic.lt` for the summarized results and `predict.ciregic.lt` for value of the predicted cumulative incidence functions. `coef` and `vcov` are the generic functions. `dataprep` for reshaping data from a long format to a suitable format to be used in the function `ciregic.lt`.

Examples

```r
## Not run:
## Set seed in order to have reproducibility of the bootstrap standard error estimate
set.seed(1234)

## Reshaping data from a long format to a suitable format
newdata <- dataprep_lt(data = longdata_lt, ID = id, time = t, W = w,
                       event = c, Z = c(z1, z2))

## Estimation of regression parameters only. No bootstrap variance estimation.
## with 'newdata'
fit_lt <- ciregic_lt(formula = Surv2(v = v, u = u, w = w, event = c) ~ z1 + z2, data = newdata,
                     alpha = c(1, 1), nboot = 0, do.par = FALSE)
fit_lt

## Bootstrap variance estimation based on 50 replications
fit_lt <- ciregic_lt(formula = Surv2(v = v, u = u, w = w, event = c) ~ z1 + z2, data = newdata,
                     alpha = c(1, 1), nboot = 50, do.par = FALSE)

## End(Not run)
## Note that the user can use parallel computing to decrease
## the computation time of the bootstrap variance-covariance
## estimation (e.g. nboot = 50)

## Summarize semiparametric regression model
summary(fit_lt)

## Predict and draw plot the cumulative incidence function evaluated at z1 = 1 and z2 = 0.5
mint <- fit_lt$tms[1]
maxt <- fit_lt$tms[2]
pred <- predict(object = fit_lt, covp = c(1, 0.5),
                times = seq(mint, maxt, by = (maxt - mint) / 99))
pred
plot(pred$t, pred$cif1, type = "l", ylim = c(0, 1))
points(pred$t, pred$cif2, type = "l", col = 2)
```

_dataprep

Data manipulation

Description

The function `dataprep` reshapes data from a long format to a ready-to-use format to be used directly in the function `ciregic`. 
Usage

dataprep(data, ID, time, event, Z)

Arguments

data a data frame that includes the variables named in the ID, time, event, and z arguments
ID a variable indicating individuals' ID
time a variable indicating observed time points
event a vector of event indicator. If an observation is right-censored, event = 0; otherwise, event = 1 or event = 2, where 1 represents the first cause of failure, and 2 represents the second cause of failure. The current version of package only allows two causes of failure.
Z a vector of variables indicating name of covariates

Details

The function dataprep provides a ready-to-use data format that can be directly used in the function ciregic. The returned data frame consists of id, v, u, c, and covariates as columns. The v and u indicate time window with the last observation time before the event and the first observation after the event. The c represents a type of event, for example, c = 1 for the first cause of failure, c = 2 for the second cause of failure, and c = 0 for the right-censored. For individuals having one time record with the event, the lower bound v will be replaced by zero, for example [0, v]. For individuals having one time record without the event, the upper bound u will be replaced by Inf, for example (v, Inf].

Value

a data frame

Author(s)

Jun Park, <jun.park@alumni.iu.edu>
Giorgos Bakoyannis, <gbakogia@iu.edu>

Examples

library(intccr)
dataprep(data = longdata, ID = id, time = t, event = c, Z = c(z1, z2))
Description

The function `dataprep_lt` reshapess data from a long format to a ready-to-use format to be used directly in the function `ciregic_lt`.

Usage

`dataprep_lt(data, ID, W, time, event, Z)`

Arguments

- `data`: a data frame that includes the variables named in the `ID`, `time`, `event`, and `z` arguments
- `ID`: a variable indicating individuals' ID
- `W`: a vector of left-truncated time points
- `time`: a variable indicating observed time points
- `event`: a vector of event indicator. If an observation is right-censored, `event = 0`; otherwise, `event = 1` or `event = 2`, where 1 represents the first cause of failure, and 2 represents the second cause of failure. The current version of package only allows two causes of failure.
- `Z`: a vector of variables indicating name of covariates

Details

The function `dataprep_lt` provides a ready-to-use data format that can be directly used in the function `ciregic_lt`. The returned data frame consists of `id`, `v`, `u`, `c`, and covariates as columns. The `v` and `u` indicate time window with the last observation time before the event and the first observation after the event. The `c` represents a type of event, for example, `c = 1` for the first cause of failure, `c = 2` for the second cause of failure, and `c = 0` for the right-censored. For individuals having one time record with the event, the lower bound `v` will be replaced by zero, for example `(0, v]`. For individuals having one time record without the event, the upper bound `u` will be replaced by `Inf`, for example `(v, Inf]`.

Value

a data frame

Author(s)

Jun Park, <jun.park@alumni.iu.edu>
Giorgos Bakoyannis, <gbakogia@iu.edu>
**dbs**

*Derivative of B-spline*

**Description**

Generates the derivative of the B-splines basis matrix.

**Usage**

```r
dbs(
  x,
  derivs = 1L,
  df = NULL,
  knots = NULL,
  degree = 3L,
  intercept = FALSE,
  Boundary.knots = range(x, na.rm = TRUE)
)
```

**Arguments**

- `x` object of B-splines
- `derivs` a number of derivatives
- `df` degrees of freedom of B-splines
- `knots` a vector of internal knots
- `degree` degrees of B-splines
- `intercept` a logical vector
- `Boundary.knots` a vector of boundary knots

**Details**

The function `dbs` performs derivatives of B-splines

**Value**

The function `dbs` returns a component:

- `dMat` B-spline matrix

**Author(s)**

Jun Park, <jun.park@alumni.iu.edu>
Giorgos Bakoyannis, <gbakogia@iu.edu>
**fit**

*Output of ciregic*

---

**Description**

Object contains the output of the function ciregic. Standard errors were estimated by the least-squares method.

**Usage**

```
fit
```

**Format**

A list of components.

**Examples**

```
fit
```

---

**fit_aipw**

*Output of ciregic_aipw*

---

**Description**

A list of outputs containing the last time prior to the event, the first time after the event, cause of failure with 50% of missingness, and covariates.

**Usage**

```
fit_aipw
```

**Format**

A list of 14:

- **call** a matched call
- **varnames** a vector containing variable names
- **varnames.aux** a vector containing auxiliary variable names
- **coefficients** a vector of the regression coefficient estimates
- **gamma** a vector of the estimated coefficients for the B-splines
- **vcov** a variance-covariance matrix of the estimated regression coefficients
- **alpha** a vector of the link function parameters
- **k** a parameter that controls the number of knots in the B-spline
loglikelihood a loglikelihood of the fitted model
convergence an indicator of convergence
tms a vector of the minimum and maximum observation times
Bv a list containing the B-splines basis functions evaluated at v
notconverged a list of number of bootstrap samples not converged

Examples
fit_aipw

fit_lt Output of ciregic_lt

Description
Object contains the output of the function ciregic_lt. Standard errors were estimated by the least-squares method.

Usage
fit_lt

Format
A list of components.

Examples
fit_lt

longdata Simulated interval-censored competing risks data - long format

Description
The data containing the subject id, series of time points, cause of failure, and covariates with 200 observations.

Usage
longdata

Format
A data frame with 868 rows and 5 variables.
longdata_lt

Examples

    library(intccr)
    data(longdata)

---

longdata_lt  Simulated left-truncated and interval-censored competing risks data - long format

Description

Data containing observation time points, a left-truncation time, cause of failure, and baseline co-

variates with 275 observations.

Usage

    longdata_lt

Format

A data frame with 275 unique individuals and 6 variables.

Examples

    library(intccr)
    data(longdata_lt)

---

naive_b  Initial values for the sieve maximum likelihood estimation

Description

The function naive_b provides a vector of initial values for the B-spline sieve maximum likelihood estimation.

Usage

    naive_b(data, w = NULL, v, u, c, q, k = 1)
Arguments

- **data**
  a data frame that includes the variables named in each argument
- **w**
  a left-truncation time (default is \( w = \text{NULL} \)).
- **v**
  the last observation time prior to the failure
- **u**
  the first observation time after the failure
- **c**
  an indicator of cause of failure, for example, if an observation is right-censored, \( \text{event} = 0 \); otherwise, \( \text{event} = 1 \) or \( \text{event} = 2 \), where 1 represents the first cause of failure, and 2 represents the second cause of failure. The current version of package only allows for two causes of failure.
- **q**
  a number of parameters in design matrix
- **k**
  a parameter that controls the number of knots in the B-spline with \( 0.5 \leq k \leq 1 \)

Details

The function `naive_b` provides initial values for the optimization procedure.

Value

- **b**
  a vector of the initial values to be used in the optimization process

Author(s)

- Giorgos Bakoyannis, <gbakogia@iu.edu>
- Jun Park, <jun.park@alumni.iu.edu>

Examples

```r
attach(simdata)
intccr::naive_b(data = simdata, v = v, u = u, c = c, q = 2)
```

predict.ciregic  
*Covariate-Specific Cumulative Incidence Prediction*

Description

predict method for class `ciregic`. It provides the predicted cumulative incidence function for a given covariate pattern and timepoint(s).

Usage

```r
## S3 method for class 'ciregic'
predict(object, covp, times, ...)
```
**predict.ciregic_aipw**

**Arguments**

- **object**: an object of class `ciregic`, which is a result of a call to `ciregic`
- **covp**: a desired values for covariates
- **times**: time points that user wants to predict value of cumulative incidence function
- ... further arguments

**Details**

`predict.ciregic` returns the predicted cumulative incidence function for a given covariate pattern and timepoint(s).

**Value**

The function `predict.ciregic` returns a list of predicted values of the model from `object`.

- **t**: time points
- **cif1**: the predicted value of cumulative incidence function for the event type 1
- **cif2**: the predicted value of cumulative incidence function for the event type 2

**See Also**

The fitted semiparametric regression on cumulative incidence function with interval-censored competing risks data `ciregic` and summary of the fitted semiparametric regression model `summary.ciregic`

**Examples**

```r
## Continuing the ciregic(...) example
pfit <- predict(object = fit, covp = c(1, 0.5), times = c(0.1, 0.15, 0.5, 0.7))
pfit
mint <- fit$tms[1]
maxt <- fit$tms[2]
pfit1 <- predict(object = fit, covp = c(1, 0.5),
                 times = seq(mint, maxt, by = (maxt-mint)/99))
plot(pfit1$t, pfit1$cif1, ylim = c(0, 1), type = "l")
lines(pfit1$t, pfit1$cif2, ylim = c(0, 1), lty = 2, col = 2)
```

---

**predict.ciregic_aipw**

*Covariate-Specific Cumulative Incidence Prediction*

**Description**

`predict` method for class `ciregic_aipw`. It provides the predicted cumulative incidence function for a given covariate pattern and timepoint(s).

**Usage**

```r
## S3 method for class 'ciregic_aipw'
predict(object, covp, times, ...)
```
Arguments

- **object**: an object of class `ciregic_aipw`, which is a result of a call to `ciregic_aipw`
- **covp**: a desired values for covariates
- **times**: time points that user wants to predict value of cumulative incidence function
- **...**: further arguments

Details

`predict.ciregic_aipw` returns the predicted cumulative incidence function for a given covariate pattern and timepoint(s).

Value

The function `predict.ciregic_aipw` returns a list of predicted values of the model from `object`.

- **t**: time points
- **cif1**: the predicted value of cumulative incidence function for the event type 1
- **cif2**: the predicted value of cumulative incidence function for the event type 2

See Also

The fitted semiparametric regression on cumulative incidence function with interval-censored competing risks data `ciregic_aipw` and summary of the fitted semiparametric regression model `summary.ciregic_aipw`

Examples

```r
## Continuing the ciregic_aipw(...) example
pfit <- predict(object = fit_aipw, covp = c(1, 0.5), times = c(0.1, 0.15, 0.5, 0.7))
pfit
mint <- fit_aipw$tms[1]
maxt <- fit_aipw$tms[2]
pfit1 <- predict(object = fit_aipw, covp = c(1, 0.5),
                 times = seq(mint, maxt, by = (maxt - mint) / 99))
plot(pfit1$t, pfit1$cif1, ylim = c(0, 1), type = "l")
lines(pfit1$t, pfit1$cif2, ylim = c(0, 1), lty = 2, col = 2)
```

predict.ciregic_lt

**Covariate-Specific Cumulative Incidence Prediction**

Description

`predict` method for class `ciregic_lt`. It provides the predicted cumulative incidence function for a given covariate pattern and timepoint(s).

Usage

```r
## S3 method for class 'ciregic_lt'
predict(object, covp, times, ...)
```
Arguments

object: an object of class ciregic_lt, which is a result of a call to ciregic_lt

covp: a desired values for covariates

times: time points that user wants to predict value of cumulative incidence function
...

Details

predict.ciregic_lt returns the predicted cumulative incidence function for a given covariate pattern and timepoint(s).

Value

The function predict.ciregic_lt returns a list of predicted values of the model from object.

t: time points

cif1: the predicted value of cumulative incidence function for the event type 1

cif2: the predicted value of cumulative incidence function for the event type 2

See Also

The fitted semiparametric regression on cumulative incidence function with interval-censored competing risks data ciregic_lt and summary of the fitted semiparametric regression model summary.ciregic_lt

Examples

## Continuing the ciregic_lt(...) example
pfit <- predict(object = fit_lt, covp = c(1, 0.5), times = c(0.1, 0.15, 0.5, 0.7))
pfit
mint <- fit_lt$tms[1]
maxt <- fit_lt$tms[2]
pfit1 <- predict(object = fit_lt, covp = c(1, 0.5),
                  times = seq(mint, maxt, by = (maxt - mint) / 99))
plot(pfit1$t, pfit1$cif1, ylim = c(0, 1), type = "l")
lines(pfit1$t, pfit1$cif2, ylim = c(0, 1), lty = 2, col = 2)

predict.dbs

Prediction of derivative of B-spline

Description

Evaluates the derivative of the B-splines basis matrix at given values.

Usage

## S3 method for class 'dbs'
predict(object, newx)
Arguments

object
returned object of B-splines
newx
a vector of points

Details

The function predict is a generic function of bs.derivs

Value

The function predict returns a predicted B-splines.

Author(s)

Giorgos Bakoyannis, <gbakogia@iu.edu>
Jun Park, <jp84@alumni.iu.edu>

Description

Artificial dataset that was simulated to resemble the HIV study on loss to HIV care and death in sub-Saharan Africa, that was presented in Bakoyannis, Yu, & Yiannoutsos (2017). It contains subject id, observation times, cause of failure, and covariates.

Usage

pseudo.HIV.long

Format

A data frame with 22710 rows and 6 variables.

References


Examples

head(pseudo.HIV.long, n = 20)
simdata

Simulated interval-censored competing risks data with 2 covariates - wide format

Description

The data containing the individual identification number, the last time point prior to the event, the first time point after the event, cause of failure, and covariates with 200 observations.

Usage

simdata

Format

A data frame with 200 rows and 6 variables.

- **id**: subject id
- **v**: the last observation time prior to the event
- **u**: the first observation time after the event
- **c**: cause of failure with missing
- **z1**: binary variable
- **z2**: continuous variable

Examples

library(intccr)
data(simdata)

simdata_aipw

Simulated interval censored data with 2 covariates in the presence of 50% of missing cause of failure - wide format

Description

The dataset containing the individual identification number, the last time prior to the event, the first time after the event, cause of failure with 50% of missingness, and covariates.

Usage

simdata_aipw
**Format**

A data frame with 200 rows and 7 variables:

- **id** subject id
- **v** the last observation time prior to the event
- **u** the first observation time after the event
- **c** cause of failure with missing
- **z1** binary variable
- **z2** continuous variable
- **a** auxiliary variable

**Examples**

```r
library(intccr)
data(simdata_aipw)
```

---

**Description**

The data containing the individual identification number, the left-truncated time, the last and first observation time prior to the event and after the event, cause of failure, and baseline covariates with 275 observations.

**Usage**

```r
simdata_lt
```

**Format**

A data frame with 275 unique individuals and 7 variables.

- **id** subject id
- **w** the left truncation time
- **v** the last observation time prior to the event
- **u** the first observation time after the event
- **c** cause of failure with missing
- **z1** binary variable
- **z2** continuous variable

**Examples**

```r
library(intccr)
data(simdata_lt)
```
**summary.ciregic**

Summary of ciregic

## Description

summary method for class ciregic

## Usage

```r
## S3 method for class 'ciregic'
summary(object, ...)
```

## Arguments

- `object`: an object of class ciregic, which is a result of a call to ciregic
- `...`: further arguments

## Details

The function `summary.ciregic` returns the coefficients, bootstrap standard errors, and etc. Additionally, 'significance star' is included.

## Value

The function `summary.ciregic` returns a list of summary statistics of the model from `object`.

- `varnames`: a vector containing variable names
- `coefficients`: a vector of the regression coefficient estimates
- `se`: a bootstrap standard error of the coefficients
- `z`: z value of the estimated coefficients
- `p`: p value of the estimated coefficients
- `call`: a matched call

## See Also

The fitted semiparametric regression on cumulative incidence function with interval-censored competing risks data `ciregic` and values of the predicted cumulative incidence functions `predict.ciregic`

## Examples

```r
## Continuing the ciregic(...) example
sfit <- summary(fit)
sfit
```
**Summary of `ciregic_aipw`**

**Description**

Summary method for class `ciregic_aipw`

**Usage**

```r
## S3 method for class 'ciregic_aipw'
summary(object, ...)
```

**Arguments**

- `object`: an object of class `ciregic_aipw`, which is a result of a call to `ciregic_aipw`
- `...`: further arguments

**Details**

The function `summary.ciregic_aipw` returns the coefficients, bootstrap standard errors, and etc. Additionally, 'significance star' is included.

**Value**

The function `summary.ciregic_aipw` returns a list of summary statistics of the model from `object`.

```r
varnames
coefficients
se
z
p
call
```

**See Also**

The fitted semiparametric regression on cumulative incidence function with interval-censored competing risks data `ciregic_aipw` and values of the predicted cumulative incidence functions `predict.ciregic_aipw`

**Examples**

```r
## Continuing the ciregic_aipw(...) example
sfit <- summary(fit_aipw)
sfit
```
Summary of ciregic_lt

Description

summary method for class ciregic_lt

Usage

## S3 method for class 'ciregic_lt'
summary(object, ...)

Arguments

object an object of class ciregic_lt, which is a result of a call to ciregic_lt
...

further arguments

Details

The function summary.ciregic_lt returns the coefficients, bootstrap standard errors, and etc. Additionally, 'significance star' is included.

Value

The function summary.ciregic_lt returns a list of summary statistics of the model from object.

varnames a vector containing variable names
coefficients a vector of the regression coefficient estimates
se a bootstrap standard error of the coefficients
z z value of the estimated coefficients
p p value of the estimated coefficients
call a matched call

See Also

The fitted semiparametric regression on cumulative incidence function with interval-censored competing risks data ciregic_lt and values of the predicted cumulative incidence functions predict.ciregic_lt

Examples

## Continuing the ciregic_lt(...) example
sfit_lt <- summary(fit_lt)
sfit_lt
Surv2

**Description**

The function `Surv2` generates the survival object to be treated as the response from `ciregic`.

**Usage**

```
Surv2(v, u, w = NULL, sub = NULL, event)
```

**Arguments**

- **v**: the last observation time prior to the failure; $0 \leq v \leq u$
- **u**: the first observation time after the failure; $u \geq 0$
- **w**: a left truncation time or delayed entry time. The default setting is `w = NULL` for non left-truncated data.
- **sub**: an indicator variable in the data set. It is an optional argument for interval-censored competing risks data and missing cause of failure, and the default is `sub = NULL`. `sub = 1` for the observations that are subject to missingness and `sub = 0` elsewhere.
- **event**: an indicator of cause of failure. If an observation is right-censored, `event = 0`; otherwise, `event = 1` or `event = 2`, where 1 represents the first cause of failure, and 2 represents the second cause of failure. The current version of package only allows for two causes of failure.

**Details**

The function `Surv2` provides a response data frame which is used in the function `ciregic` and `ciregic_lt`. For interval-censored competing risks data, the function `Surv2` must use three parameters ($v$, $u$, $c$). For left-truncated and interval censored competing risks data, the function `Surv2` must use four parameters ($v$, $u$, $w$, $c$). If data are partially left-truncated, but all interval-censored, $w = 0$ for only interval-censored competing risks data.

**Value**

data frame

**Author(s)**

Jun Park, <jun.park@alumni.iu.edu>

Giorgos Bakoyannis, <gbakogia@iu.edu>
vcov.ciregic

Examples

attach(simdata)
Surv2(v = v, u = u, event = c)
attach(simdata_1t)
Surv2(v = v, u = u, w = w, event = c)

---

v cov . ciregic Variance-covariance matrix of ciregic

Description

vcov method for class ciregic

Usage

## S3 method for class 'ciregic'
vcov(object, ...)

Arguments

object an object of class ciregic, which is a result of a call to ciregic
...

Details

The function vcov returns the variance-covariance matrix of the fitted semiparametric regression model.

Value

The estimated bootstrap variance-covariance matrix

See Also

The fitted semiparametric regression on cumulative incidence function with interval-censored competing risks data ciregic, summary of the fitted semiparametric regression model summary.ciregic, and values of predicted cumulative incidence functions predict.ciregic

Examples

## Continuing the ciregic(...) example
vcov(fit)
vcov.ciregic_aipw  Variance-covariance matrix of ciregic_aipw

Description

vcov method for class ciregic_aipw

Usage

## S3 method for class 'ciregic_aipw'
vcov(object, ...)

Arguments

object  an object of class ciregic_aipw, which is a result of a call to ciregic_aipw
...
  further arguments

Details

The function vcov returns the variance-covariance matrix of the fitted semiparametric regression model.

Value

The estimated bootstrap variance-covariance matrix

See Also

The fitted semiparametric regression on cumulative incidence function with interval-censored competing risks data ciregic_aipw, summary of the fitted semiparametric regression model summary.ciregic_aipw, and values of predicted cumulative incidence functions predict.ciregic_aipw

Examples

## Continuing the ciregic_aipw(...) example
vcov(fit_aipw)
vcov.ciregic_lt

Variance-covariance matrix of ciregic_lt

Description
vcov method for class ciregic_lt

Usage
## S3 method for class 'ciregic_lt'
vcov(object, ...)

Arguments
object an object of class ciregic_lt, which is a result of a call to ciregic_lt
...
进一步 arguments

Details
The function vcov returns the variance-covariance matrix of the fitted semiparametric regression model.

Value
The estimated bootstrap variance-covariance matrix

See Also
The fitted semiparametric regression on cumulative incidence function with interval-censored competing risks data ciregic_lt, summary of the fitted semiparametric regression model summary.ciregic_lt, and values of predicted cumulative incidence functions predict.ciregic_lt

Examples
## Continuing the ciregic_lt(...) example
vcov(fit_lt)
Description

vcov method for class summary.ciregic

Usage

## S3 method for class 'summary.ciregic'
vcov(object, ...)

Arguments

object an object of class summary.ciregic, which is a result of a call to ciregic
...
    further arguments

Details

The vcov returns the variance-covariance matrix of the fitted semiparametric regression model.

Value

The estimated bootstrap variance-covariance matrix

See Also

The fitted semiparametric regression on cumulative incidence function with interval-censored competing risks data ciregic, summary of the fitted semiparametric regression model summary.ciregic, and values of the predicted cumulative incidence functions predict.ciregic

Examples

## Continuing the ciregic(...) example
vcov(summary(fit))
Description

vcov method for class summary.ciregic_aipw

Usage

## S3 method for class 'summary.ciregic_aipw'
vcov(object, ...)

Arguments

object an object of class summary.ciregic_aipw, which is a result of a call to ciregic_aipw
...

Details

The vcov returns the variance-covariance matrix of the fitted semiparametric regression model.

Value

The estimated bootstrap variance-covariance matrix

See Also

The fitted semiparametric regression on cumulative incidence function with interval-censored competing risks data ciregic_aipw, summary of the fitted semiparametric regression model summary.ciregic_aipw, and values of the predicted cumulative incidence functions predict.ciregic_aipw

Examples

## Continuing the ciregic_aipw(...) example
vcov(summary(fit_aipw))
Variance-covariance matrix of summary.ciregic_lt

Description
vcov method for class summary.ciregic_lt

Usage
## S3 method for class 'summary.ciregic_lt'
vcov(object, ...)

Arguments
object an object of class summary.ciregic_lt, which is a result of a call to ciregic_lt
...

Details
The vcov returns the variance-covariance matrix of the fitted semiparametric regression model.

Value
The estimated bootstrap variance-covariance matrix

See Also
The fitted semiparametric regression on cumulative incidence function with interval-censored competing risks data ciregic_lt, summary of the fitted semiparametric regression model summary.ciregic_lt, and values of the predicted cumulative incidence functions predict.ciregic_lt

Examples
## Continuing the ciregic_lt(...) example
tvcov(summary(fit_lt))
waldtest

**Wald test for ciregic and ciregic_lt**

**Description**

waldtest for class ciregic or ciregic_lt. This provides the result of Wald test for the fitted model from the function ciregic or ciregic_lt.

**Usage**

waldtest(obj1, obj2 = NULL, ...)

**Arguments**

- **obj1**: an object of the fitted model in ciregic or ciregic_lt
- **obj2**: an object of the fitted model in ciregic or ciregic_lt, the default is NULL
- **...**: further arguments

**Details**

The function waldtest.ciregic returns a result of Wald test.

**Value**

The function waldtest returns an output table of Wald test of the model from object.

- **varnames.full**: a variable name of a vector of variables names in the full model
- **varnames.nested**: a variable name of a vector of variables names in the nested model
- **vcov**: the estimated bootstrap variance-covariance matrix for overall Wald test
- **vcov.event1**: the estimated bootstrap variance-covariance matrix for cause-specific Wald test (event type 1)
- **vcov.event2**: the estimated bootstrap variance-covariance matrix for cause-specific Wald test (event type 2)
- **table**: a table including test statistic, degrees of freedom, and p-value

**Author(s)**

Jun Park, <jun.park@alumni.iu.edu>

Giorgos Bakoyannis, <gbakogia@iu.edu>

**See Also**

The fitted semiparametric regression on cumulative incidence function with interval-censored competing risks data ciregic and left-truncated and interval-censored competing risks data ciregic_lt
Examples

```r
## Continuing the ciregic(...) example
library(intccr)
waldtest(obj1 = fit)
set.seed(12345)
newdata <- dataprep(data = longdata, ID = id, time = t,
                   event = c, Z = c(z1, z2))
fit.nested <- ciregic(formula = Surv2(v = v, u = u, event = c) ~ z2, data = newdata,
                      alpha = c(1, 1), nboot = 0, do.par = FALSE)
waldtest(obj1 = fit, obj2 = fit.nested)
```
Index

* Surv2
  Surv2, 36
* bs.derivs
  bs.derivs, 3
* bssmle_aipw_se
  bssmle_se.aipw, 10
* bssmle_aipw
  bssmle_aipw, 5
* bssmle_lse_lt
  bssmle_lse_lt, 7
* bssmle_lse
  bssmle_lse, 6
* bssmleLt
  bssmle_Lt, 8
* bssmle_se
  bssmle_se, 9
* bssmle
  bssmle, 4
* ciregic_aipw
  ciregic_aipw, 14
* ciregic_Lt
  ciregic_Lt, 17
* ciregic
  ciregic, 11
* dataprep_Lt
  dataprep_Lt, 21
* dataprep
  dataprep, 19
* datasets
  longdata, 24
  longdata.Lt, 25
  pseudo.HIV.long, 30
  simdata, 31
  simdata_aipw, 31
  simdata.Lt, 32
* dbs
  dbs, 22
* naive_b
  naive_b, 25

* output
  fit, 23
  fit.aipw, 23
  fit.Lt, 24
* predict
  predict.dbs, 29
  bs.derivs, 3
  bssmle, 4
  bssmle_aipw, 5
  bssmle_Lse, 6
  bssmle_Lse廖, 7
  bssmle_Lt, 8
  bssmle_se, 9
  bssmle_se.aipw, 10
  ciregic, 11, 27, 33, 37, 40, 43
  ciregic_aipw, 14, 28, 34, 38, 41
  ciregic_Lt, 17, 29, 35, 39, 42, 43
  dataprep, 13, 19, 19
  dataprep.Lt, 21
  dbs, 22
  fit, 23
  fit.aipw, 23
  fit.Lt, 24
  longdata, 24
  longdata.Lt, 25
  naive_b, 25
  predict.ciregic, 13, 26, 33, 37, 40
  predict.ciregic_aipw, 16, 27, 34, 38, 41
  predict.ciregic_Lt, 19, 28, 35, 39, 42
  predict.dbs, 29
  pseudo.HIV.long, 30
  simdata, 31
  simdata.aipw, 31
simdata lt, 32
summary.ciregic, 13, 27, 33, 33, 37, 40
summary.ciregic_aipw, 16, 28, 34, 34, 38, 41
summary.ciregic_lt, 19, 29, 35, 35, 39, 42
Surv2, 36

vcov.ciregic, 37
vcov.ciregic_aipw, 38
vcov.ciregic_lt, 39
vcov.summary.ciregic, 40
vcov.summary.ciregic_aipw, 41
vcov.summary.ciregic_lt, 42

waldtest, 43