Package ‘survivalREC’

March 15, 2022

Type Package

Title Nonparametric Estimation of the Distribution of Gap Times for Recurrent Events

Version 1.0

Date 2022-03-09

Description Provides estimates for the bivariate and trivariate distribution functions and bivariate and trivariate survival functions for censored gap times. Two approaches, using existing methodologies, are considered: (i) the Lin's estimator, which is based on the extension the Kaplan-Meier estimator of the distribution function for the first event time and the Inverse Probability of Censoring Weights for the second time (Lin DY, Sun W, Ying Z (1999) <doi:10.1093/biomet/86.1.59> and (ii) another estimator based on Kaplan-Meier weights (Una-Alvarez J, Meira-Machado L (2008) <https://w3.math.uminho.pt/~lmachado/Biometria_conference.pdf>). The proposed methods are the landmark estimators based on subsampling approach, and the estimator based on weighted cumulative hazard estimator. The package also provides nonparametric estimator conditional to a given continuous covariate. All these methods have been submitted to be published.

License GPL-3

Depends R (>= 3.5.0)

Imports survival, KernSmooth, graphics, stats, utils

RoxygenNote 7.1.2

Encoding UTF-8

LazyLoad yes

LazyData yes

NeedsCompilation yes

Suggests rmarkdown, knitr

VignetteBuilder knitr
Author  Gustavo Soutinho [aut, cre] (<https://orcid.org/0000-0002-0559-1327>),
         Luis Meira-Machado [aut] (<https://orcid.org/0000-0002-8577-7665>),
         Artur Araujo [ctb] (<https://orcid.org/0000-0003-1419-4208>),
         Ana Moreira [ctb]

Maintainer  Gustavo Soutinho <gustavosoutinho@sapo.pt>

Repository  CRAN

Date/Publication  2022-03-15 18:50:05 UTC

R topics documented:

b3 .................................................. 3
b3size ........................................... 3
b3state ......................................... 4
b3state2 ....................................... 5
b4 .................................................. 5
b4state ........................................ 6
Beran ............................................ 7
bladder3 ....................................... 8
bladder3state ................................ 9
bladder4 ....................................... 9
bladder4state ................................ 10
bladder5 ....................................... 11
bladder5state ................................ 11
IPCWdf .......................................... 12
KM ................................................ 14
KMW .............................................. 15
KMW3df ......................................... 16
KMWdf .......................................... 17
LDM3df ......................................... 18
LDMdf .......................................... 19
LIN3df .......................................... 20
LINdf ........................................... 21
multidf .......................................... 22
NWW ............................................ 23
plot.multidf .................................. 24
WCH3df ......................................... 26
WCHdf .......................................... 27

Index  29
Description

b3 data set.

Usage

data("b3")

Format

A data frame with 85 observations on the following 4 variables. Below a brief description is given for each of these variables.

- **time1**: First time or censoring time.
- **time**: The total time of the process.
- **event1**: Indicator of the first time; 0 if the first time is censored and 1 otherwise.
- **status**: Censoring indicator of the survival time of the process; 0 if the total time is censored and 1 otherwise.

Examples

data(b3)
head(b3)

Description

b3size data set.

Usage

data("b3size")
Format

A data frame with 85 observations on the following 5 variables. Below a brief description is given for each of these variables.

- **time1** First time or censoring time.
- **time** The total time of the process.
- **event1** Indicator of the first time; 0 if the first time is censored and 1 otherwise.
- **status** Censoring indicator of the survival time of the process; 0 if the total time is censored and 1 otherwise.
- **size** Values of covariate size.

Examples

data(b3size)

---

Description

b3state data set.

Usage

data("b3state")

Format

A data frame with 85 observations on the following 4 variables. Below a brief description is given for each of these variables.

- **time1** First time or censoring time.
- **time** The total time of the process.
- **event1** Indicator of the first time; 0 if the first time is censored and 1 otherwise.
- **status** Censoring indicator of the survival time of the process; 0 if the total time is censored and 1 otherwise.

Examples

data(b3state)
str(b3state)
Description

b3state2 data set

Usage

data("b3state2")

Format

A data frame with 85 observations on the following 5 variables. Below a brief description is given for each of these variables.

- **time1**: First time or censoring time.
- **time**: The total time of the process
- **event1**: Indicator of the first time; 0 if the first time is censored and 1 otherwise.
- **status**: Censoring indicator of the survival time of the process; 0 if the total time is censored and 1 otherwise.
- **size**: Values of covariate size.

Examples

data(b3state2)
str(b3state2)

Description

b4 data set.

Usage

data("b4")
Format
A data frame with 85 observations on the following 6 variables. Below a brief description is given for each of these variables.

time1 First time or censoring time.
time2 Second time.
time The total time of the process
event1 Indicator of the first time; 0 if the first time is censored and 1 otherwise.
event2 Indicator of the second time; 0 if the first time is censored and 1 otherwise.
status Censoring indicator of the survival time of the process; 0 if the total time is censored and 1 otherwise.

Examples
data(b4)
head(b4)

---

b4state b4state

Description
b4state data set.

Usage
data("b4state")

Format
A data frame with 85 observations on the following 6 variables. Below a brief description is given for each of these variables.

time1 First time or censoring time.
time2 Second time.
time The total time of the process
event1 Indicator of the first time; 0 if the first time is censored and 1 otherwise.
event2 Indicator of the second time; 0 if the first time is censored and 1 otherwise.
status Censoring indicator of the survival time of the process; 0 if the total time is censored and 1 otherwise.

Examples
data(b4state)
## maybe str(b4state) ; plot(b4state) ...
Estimation of the conditional distribution function of the response, given the covariate under random censoring.

Description

Computes the conditional survival probability $P(T > y|Z = z)$

Usage

```r
Beran(time, status, covariate, delta, x, y, kernel = "gaussian", bw, lower.tail = FALSE)
```

Arguments

- `time` : The survival time of the process.
- `status` : Censoring indicator of the total time of the process; 0 if the total time is censored and 1 otherwise.
- `covariate` : Covariate values for obtaining estimates for the conditional probabilities.
- `delta` : Censoring indicator of the covariate.
- `x` : The first time (or covariate value) for obtaining estimates for the conditional probabilities. If missing, 0 will be used.
- `y` : The total time for obtaining estimates for the conditional probabilities.
- `kernel` : A character string specifying the desired kernel. See details below for possible options. Defaults to "gaussian" where the gaussian density kernel will be used.
- `bw` : A single numeric value to compute a kernel density bandwidth.
- `lower.tail` : logical; if FALSE (default), probabilities are $P(T > y|Z = z)$ otherwise, $P(T \leq y|Z = z)$.

Details

Possible options for argument `window` are "gaussian", "epanechnikov", "tricube", "boxcar", "triangular", "quartic" or "cosine"

Value

Vector with the estimation of the conditional distribution function of the response, given the covariate under random censoring.

Author(s)

Gustavo Soutinho and Luis Meira-Machado
References


Examples

data("bladder4state")
b3state<-multidf(gap1=bladder4state$y1, event1=bladder4state$d1,  
gap2=bladder4state$y2, status=bladder4state$d2,  
size=bladder4state$size)

head(b3state[[1]])  
##P(T>y|size=3)
library(KernSmooth)

obj0 <- b3state[[1]]

h <- dpik(obj0$size)
Beran(time = obj0$time, status = obj0$status, covariate =obj0$size, x = 3,
y = 50, bw = h)

##P(T<=y|size=3)
Beran(time = obj0$time, status = obj0$status, covariate =obj0$size, x = 3,
y = 50, bw = h, 
lower.tail = TRUE)

---

bladder3

### Description

bladder3-description

### Usage

data("bladder3")

### Format

A data frame with 85 observations on the following 6 variables.

- **t1** First time or censoring time.
- **d1** Indicator of the first time; 0 if the first time is censored and 1 otherwise.
- **t2** The total time of the process
- **d2** Censoring indicator of the survival time of the process; 0 if the total time is censored and 1 otherwise.
- **rx** Values of covariate rx.
- **size** Values of covariate size.
**bladder3state**

**Examples**

```r
data(bladder3)
str(bladder3)
```

<table>
<thead>
<tr>
<th>bladder3state</th>
<th>bladder3state</th>
</tr>
</thead>
</table>

**Description**

bladder3state data set.

**Usage**

```r
data("bladder3state")
```

**Format**

A data frame with 85 observations on the following 7 variables.

- `id` Identification number.
- `y1` First gap time.
- `d1` Indicator of the first gap time; 0 if the first time is censored and 1 otherwise.
- `y2` Second gap time.
- `d2` Censoring indicator of the second gap time; 0 if the total time is censored and 1 otherwise.
- `rx` Values of covariate rx.
- `size` Values of covariate size.

**Examples**

```r
data(bladder3state)
str(bladder3state)
```

<table>
<thead>
<tr>
<th>bladder4</th>
<th>bladder4</th>
</tr>
</thead>
</table>

**Description**

bladder4 data set.

**Usage**

```r
data("bladder4")
```
Format

A data frame with 85 observations on the following 8 variables.

- **t1**: First time or censoring time.
- **d1**: Indicator of the first time; 0 if the first time is censored and 1 otherwise.
- **t2**: Second time or censoring time.
- **d2**: Indicator of the second time; 0 if the first time is censored and 1 otherwise.
- **t3**: The total time of the process.
- **d3**: Censoring indicator of the survival time of the process; 0 if the total time is censored and 1 otherwise.
- **rx**: Values of covariate rx.
- **size**: Values of covariate size.

Examples

data(bladder4)

## Description

bladder4state data set.

## Usage

data("bladder4state")

## Format

A data frame with 85 observations on the following 9 variables.

- **id**: Identification number.
- **y1**: First gap time.
- **d1**: Indicator of the first gap time; 0 if the first time is censored and 1 otherwise.
- **y2**: Second gap time.
- **d2**: Censoring indicator of the second gap time; 0 if the total time is censored and 1 otherwise.
- **y3**: Third gap time.
- **d3**: Censoring indicator of the third gap time; 0 if the total time is censored and 1 otherwise.
- **rx**: Values of covariate rx.
- **size**: Values of covariate size.

## Examples

data(bladder4state)
Description

bladder5 data set.

Usage

data("bladder5")

Format

A data frame with 85 observations on the following 10 variables.

- **t1**: First time or censoring time.
- **d1**: Indicator of the first time; 0 if the first time is censored and 1 otherwise.
- **t2**: Second time or censoring time.
- **d2**: Indicator of the second time; 0 if the first time is censored and 1 otherwise.
- **t3**: Third time or censoring time.
- **d3**: Indicator of the third time; 0 if the first time is censored and 1 otherwise.
- **t4**: The total time of the process
- **d4**: Censoring indicator of the survival time of the process; 0 if the total time is censored and 1 otherwise.
- **rx**: Values of covariate rx.
- **size**: Values of covariate size.

Examples

data(bladder5)

Description

bladder5state data set.

Usage

data("bladder5state")
Format

A data frame with 85 observations on the following 11 variables.

- id  Identification number.
- y1  First gap time.
- d1  Indicator of the first gap time; 0 if the first time is censored and 1 otherwise.
- y2  Second gap time.
- d2  Censoring indicator of the second gap time; 0 if the total time is censored and 1 otherwise.
- y3  Third gap time.
- d3  Censoring indicator of the third gap time; 0 if the total time is censored and 1 otherwise.
- y4  Fourth gap time.
- d4  Censoring indicator of the fourth gap time; 0 if the total time is censored and 1 otherwise.
- rx  Values of covariate rx.
- size Values of covariate size.

Examples

data(bladder5state)

IPCWdf

Inverse probability of censoring weighting estimator for the bivariate distribution function.

Description

Provides estimates for the bivariate distribution function based on the Inverse Probability of Censoring Weighting estimator (IPCW).

Usage

IPCWdf(object, x, y, covariate, cov.value, bw, window = "gaussian")

Arguments

- object An object of class multidf.
- x       The first time for obtaining estimates for the bivariate distribution function.
- y       The second time for obtaining estimates for the bivariate distribution function.
- covariate Name of the quantitative covariate.
- cov.value The value of the quantitative covariate.
- bw       A single numeric value to compute a kernel density bandwidth. Use "dpik" for the KernSmooth package based selector or "np" for the npudensbw function of the np package.
- window   A character string specifying the desired kernel. See details below for possible options. Defaults to "gaussian" where the gaussian density kernel will be used.
Value

Vector with the IPWC estimates for the bivariate distribution function.

Author(s)

Gustavo Soutinho and Luis Meira-Machado.

References


See Also

kmWdf, lmdf, lindf and wchdf.

Examples

data("bladder4state")

b3state<-multidf(gap1=bladder4state$y1, event1=bladder4state$d1,
    gap2=bladder4state$y2, status=bladder4state$d2,
    size=bladder4state$size)

b3size<-multidf(gap1=bladder3$t1, event1=bladder3$d1,
    gap2=bladder3$t2-bladder3$t1,status=bladder4state$d2,
    size=bladder3$size)

library(KernSmooth)

IPCWdf(object=b3state, x=13, y=15, covariate="size", cov.value=3,
    window = "gaussian")

IPCWdf(object=b3state, x=13, y=15, covariate="size", bw=2, cov.value=3,
    window = "gaussian")

IPCWdf(object=b3size, x=13, y=15, covariate="size", cov.value=3,
    window = "gaussian")

IPCWdf(object=b3size, x=13, y=15, covariate="size", bw=2, cov.value=3,
    window = "gaussian")
**Description**

This function provides survival estimates using the product-limit Kaplan-Meier estimator.

**Usage**

\[
\text{KM}(\text{time}, \text{status}, \text{t})
\]

**Arguments**

- **time**: Survival time of the process.
- **status**: Censoring indicator of the survival time of the process; 0 if the survival time is censored and 1 otherwise.
- **t**: The time for obtaining survival estimates.

**Value**

Vector with Kaplan-Meier estimate of survival.

**Author(s)**

Gustavo Soutinho and Luis Meira-Machado

**References**


**Examples**

```r
require(survival)
data("bladder4state")

obj< multdf(gap1=bladder4state$y1, event1=bladder4state$d1,
gap2=bladder4state$y2, status=bladder4state$d2,
size=bladder4state$size)

obj2<-obj[[1]]
KM(time = obj2$time, status = obj2$status, t = 20)
fit <- survfit(Surv(obj2$time, obj2$status) ~ 1, data = obj2)
summary(fit, time = 20)$surv
```
KMW

Kaplan-Meier weights

Description

This function returns a vector with the Kaplan-Meier weights.

Usage

KMW(time, status)

Arguments

time
Survival time of the process.

status
Censoring indicator of the survival time of the process; 0 if the survival time is
censored and 1 otherwise.

Value

Vector with Kaplan-Meier weights.

Author(s)

Gustavo Soutinho and Luis Meira-Machado

References

E. Kaplan and P. Meier. Nonparametric estimation from incomplete observations. Journal of the

Examples

data("bladder4state")

obj<- multiid(gap1=bladder4state$y1, event1=bladder4state$d1,
gap2=bladder4state$y2, status=bladder4state$d2,
size=bladder4state$size)

obj2<-obj[[1]]

kmw <- KMW(time = obj2$time, status = obj2$status)

require(survival)

bladder.surv <- survfit(Surv(time, status) ~ 1, obj2)
times <- summary(bladder.surv)$time
surv <- summary(bladder.surv)$surv
nevent <- summary(bladder.surv)$n.event

p <- match(obj2$time, times)

kmw2 <- -diff(c(1, surv))/nevent

kmw2 <- kmw2[p]*obj2$status

kmw2[is.na(kmw2)] <- 0
all.equal(kmw, kmw2)

KMW3df

Kaplan-Meier Weighted estimator for three gap times distribution function.

Description

Provides estimates for three gap times distribution function based on Kaplan-Meier Weights (KMW).

Usage

KMW3df(object, x, y, z)

Arguments

object
An object of class multidf.

x
The first time for obtaining estimates for the trivariate distribution function.

y
The second time for obtaining estimates for the trivariate distribution function.

z
The third time for obtaining estimates for the trivariate distribution function.

Value

Vector with the Kaplan-Meier Weighted estimates for three gaps times distribution function.

Author(s)

Gustavo Soutinho and Luis Meira-Machado

References


See Also

LDM3df, LIN3df and WCH3df.
### Examples

```r
data("bladder5state")
b4state<-multidf(gap1=bladder5state$y1, event1=bladder4state$d1, gap2=bladder5state$y2, event2=bladder4state$d2, gap3=bladder5state$y3, status=bladder4state$d3)
head(b4state)[[1]]

KMW3df(b4state, x=13, y=20, z=40)

b4<-multidf(gap1=bladder4$t1, event1=bladder4$d1, gap2=bladder4$t2-bladder4$t1, event2=bladder4$d2, gap3=bladder4$t3-bladder4$t2, status=bladder4state$d3)

KMW3df(b4, x=13, y=20, z=40)
```

---

### Description

Provides estimates for the bivariate distribution function based on Kaplan-Meier Weights (KMW).

### Usage

```r
KMWdf(object, x, y)
```

### Arguments

- **object**: An object of class `multidf`.
- **x**: The first time for obtaining estimates for the bivariate distribution function.
- **y**: The second time for obtaining estimates for the bivariate distribution function.

### Value

Vector with the Kaplan-Meier weights estimates for the bivariate distribution function.

### Author(s)

Gustavo Soutinho and Luis Meira-Machado

### References


See Also

`IPCdf`, `LDMdf`, `LINdf` and `WCHdf`.

Examples

```r
data("bladder4state")

b3state <- multidf(gap1=bladder4state$y1, event1=bladder4state$d1,
                   gap2=bladder4state$y2, status=bladder4state$d2,
                   size=bladder4state$size)

KMpdf(b3state, x=13, y=20)
```

LDM3df  

*Landmark estimator for three gap times distribution function.*

Description

Provides estimates for three gap times distribution function based on landmarking. The extension of the landmark estimator (LDM) to three gap times is a consequence of Bayes’ theorem.

Usage

```r
LDM3df(object, x, y, z)
```

Arguments

- **object**: An object of class multidf.
- **x**: The first time for obtaining estimates for the trivariate distribution function.
- **y**: The second time for obtaining estimates for the trivariate distribution function.
- **z**: The third time for obtaining estimates for the trivariate distribution function.

Value

Vector with the Landmark estimates for three gap times distribution function.

Author(s)

Gustavo Soutinho and Luis Meira-Machado

References


See Also

LDMdf, LIN3df and WCH3df.

Examples

data("bladder5state")
b4state<-multidf(gap1=bladder5state$y1, event1=bladder4state$d1, gap2=bladder5state$y2, event2=bladder4state$d2, gap3=bladder5state$y3, status=bladder4state$d3)

head(b4state)[[1]]
LDM3df(b4state, x=13, y=20, z=40)

b4<-multidf(gap1=bladder4$t1, event1=bladder4$d1, gap2=bladder4$t2-bladder4$t1, event2=bladder4$d2, gap3=bladder4$t3-bladder4$t2, status=bladder4state$d3)

LDM3df(b4,x=13,y=20,z=40)

LDMdf

Landmark estimator for the bivariate distribution function

Description

Provides estimates for the bivariate distribution function based on Bayes’ theorem and Kaplan-Meier survival function. This approach is also named as landmarking.

Usage

LDMdf(object, x, y)

Arguments

object An object of class multidf.
x The first time for obtaining estimates for the bivariate distribution function.
y The second time for obtaining estimates for the bivariate distribution function.

Value

Vector with the Landmark estimates for the bivariate distribution function.

Author(s)

Gustavo Soutinho and Luis Meira-Machado
References


See Also

IPCdf, KMMdf, LIndf and WChdf.

Examples

```r
b3state <- multidf(gap1 = bladder4state$y1, event1 = bladder4state$d1, 
                  gap2 = bladder4state$y2, status = bladder4state$d2, 
                  size = bladder4state<size>)

LDMdf(b3state, x = 13, y = 20)
```

LIN3df

Lin’s estimator for three gap times distribution function.

Description

Provides estimates for three gap times distribution function based on the extension the Lin’s estimator.

Usage

LIN3df(object, x, y, z)

Arguments

- **object**: An object of class multidf.
- **x**: The first time for obtaining estimates for the trivariate distribution function.
- **y**: The second time for obtaining estimates for the trivariate distribution function.
- **z**: The third time for obtaining estimates for the trivariate distribution function.

Value

Vector with the Lin’s estimates for three gaps times distribution function.

Author(s)

Gustavo Soutinho and Luis Meira-Machado
References

See Also
LDM3df, KMW3df and WCH3df.

Examples

```r
data("bladder5state")
b4state<-multidf(gap1=bladder5state$y1, event1=bladder4state$d1, gap2=bladder5state$y2, event2=bladder4state$d2, gap3=bladder5state$y3, status=bladder4state$d3)

head(b4state)[[1]]
LIN3df(b4state, x=13, y=20, z=40)

b4<-multidf(gap1=bladder4$t1, event1=bladder4$d1, gap2=bladder4$t2-bladder4$t1, event2=bladder4$d2, gap3=bladder4$t3-bladder4$t2, status=bladder4state$d3)

LIN3df(b4, x=13, y=20, z=40)
```

LINdf

*Lin’s estimator for the bivariate distribution function.*

Description
Provides estimates for the bivariate distribution function based on the extension the Kaplan-Meier estimator of the distribution function for the first event time and the Inverse Probability of Censoring Weights for the second time.

Usage

```
LINdf(object, x, y)
```

Arguments

- **object**: An object of class multidf.
- **x**: The first time for obtaining estimates for the bivariate distribution function.
- **y**: The second time for obtaining estimates for the bivariate distribution function.

Value

Vector with the Lin’s estimates for the bivariate distribution function.
Author(s)
Gustavo Soutinho and Luis Meira-Machado

References

See Also
IPCWdf, LDMdf, KMWdf and WCHdf.

Examples

b3state<-multidf(gap1=bladder4state$y1, event1=bladder4state$d1, gap2=bladder4state$y2, status=bladder4state$d2, size=bladder4state$size)
LINdf(b3,x=13,y=20)

multidf

Create a multidf object

Description
 Creates a "multidf" object, usually used as a response variable in a model formula.

Usage

multidf(gap1, gap2, gap3=NULL, event1, status, event2=NULL, ...)

Arguments

gap1 First gap time.
gap2 Second gap time.
gap3 Third gap time. By default is NULL.
event1 Indicator of the first time; 0 if the first time is censored and 1 otherwise.
status Censoring indicator of the survival time of the process; 0 if the total time is censored and 1 otherwise. For instance, for three gap times, status is given by the indicator of the third time.
event2 Indicator of the second time; 0 if the first time is censored and 1 otherwise. By default is NULL.
... Other options. Additional arguments, such as covariates, can also be included in the data set.
Details
Arguments in this function must be introduced in the following order: gap1, event1, gap2 and status, where gap1 and gap2 are ordered event times and event1 and status their corresponding indicator statuses. Other arguments can be also added. These should consider intermediate times and corresponding censoring indicators or covariates.

Value
An object of class "multidf". "multidf" objects are implemented as a single data frame.

Author(s)
Gustavo Soutinho and Luis Meira-Machado

Examples
library(survivalREC)
data("bladder4state")

b3state<-multidf(gap1=bladder4state$y1, event1=bladder4state$d1,
gap2=bladder4state$y2, status=bladder4state$d2,
size=bladder4state$size)

head(b3state[[1]])
class(b3state)

b4state<-multidf(gap1=bladder4state$y1, event1=bladder4state$d1,
gap2=bladder4state$y2, event2=bladder4state$d2,
gap3=bladder4state$y3, status=bladder4state$d3,
size=bladder4state$size)

head(b4state[[1]])

Description
Nadaraya-Watson weights

Usage
NWW(covariate, x, kernel = "gaussian", bw)
**Arguments**

- `covariate` Covariate values for obtaining weights.
- `x` Covariate value to compute the weight at.
- `kernel` A character string specifying the desired kernel. See details below for possible options. Defaults to "gaussian" where the gaussian density kernel will be used.
- `bw` A single numeric value to compute a kernel density bandwidth.

**Details**

Possible options for argument window are "gaussian", "epanechnikov", "tricube", "boxcar", "triangular", "quartic" or "cosine".

**Value**

A vector with Nadaraya-Watson weights.

**Author(s)**

Gustavo Soutinho and Luis Meira-Machado

**Examples**

```r
b3state<-multidf(gap1=bladder4state$y1, event1=bladder4state$d1, gap2=bladder4state$y2, status=bladder4state$d2, size=bladder4state$size)

obj0 <- b3state[[1]]

NWW(covariate = obj0$size, x=3, kernel = "gaussian", bw = 3)
```

---

**plot.multidf**

*Plot methods for a multidf object*

**Description**

Provides the plots for the bivariate distribution function and marginal distribution of the second time.

**Usage**

```r
## S3 method for class 'multidf'
plot(x, t1, method = "KMW", type = "s", ...)
```
Arguments

- **x**: An object of class multidf.
- **t1**: Value of the first gap time.
- **method**: A character string specifying which estimator to fit. Possible values are "KMW", "LIN", "WCH" and "LANDMARK".
- **type**: The type of plot that should be drawn. See details `par` for possible options. Defaults to "s" for the draw be stair steps.
- **...**: Other options.

Value

No value is returned.

Author(s)

Gustavo Soutinho and Luis Meira-Machado

References


See Also

`KMWdf`, `LDMdf`, `LINdf` and `WCHdf`.

Examples

data("bladder4state")

b3state<-multidf(gap1=bladder4state$y1, event1=bladder4state$d1, gap2=bladder4state$y2, status=bladder4state$d2, size=bladder4state$size)

head(b3state[[1]])

KMWdf(b3state, x=13, y=20)
LDMdf(b3state, x=13, y=20)
LINdf(b3state, x=13, y=20)
WCHdf(b3state, x=13, y=20)

plot(x=b3state, t1=3, method="KMW", type = "s")
plot(x=b3state, t1=3, method="LIN", type = "s")
plot(x=b3state, t1=3, method="WCH", type = "s")
plot(x=b3state, t1=3, method="LANDMARK", type = "s")

---

WCH3df  
*Weighted cumulative hazard estimator for three gap times distribution function.*

**Description**

Provides estimates for three gap times distribution function based on Weighted cumulative hazard estimator (WCH).

**Usage**

`WCH3df(object, x, y, z)`

**Arguments**

- `object`  
  An object of class `multidf`.
- `x`  
  The first time for obtaining estimates for the three gap times distribution function.
- `y`  
  The second time for obtaining estimates for the three gap times distribution function.
- `z`  
  The third time for obtaining estimates for the three gap times distribution function.

**Value**

Vector with the Weighted cumulative hazard estimates for three gap times distribution function.

**Author(s)**

Gustavo Soutinho and Luis Meira-Machado

**References**


**See Also**

`KMW3df`, `LIN3df` and `LDM3df`. 
**Examples**

```r
data("bladder5state")

b4state<-multidf(gap1=bladder5state$y1, event1=bladder4state$d1,
gap2=bladder5state$y2, event2=bladder4state$d2,
gap3=bladder5state$y3, status=bladder4state$d3)

head(b4state)[[1]]

WCH3df(b4state, x=13, y=20, z=40)

b4<-multidf(gap1=bladder4$t1, event1=bladder4$d1,
gap2=bladder4$t2-bladder4$t1, event2=bladder4$d2,
gap3=bladder4$t3-bladder4$t2, status=bladder4state$d3)

WCH3df(b4, x=13, y=20, z=40)
```

---

**WCHdf**

Weighted cumulative hazard estimator for the bivariate distribution function

**Description**

Provides estimates for the bivariate distribution function based on Weighted cumulative hazard estimator (WCH).

**Usage**

```r
WCHdf(object, x, y)
```

**Arguments**

- **object**: An object of class multidf.
- **x**: The first time for obtaining estimates for the bivariate distribution function.
- **y**: The second time for obtaining estimates for the bivariate distribution function.

**Value**

Vector with the Weighted cumulative hazard estimates for the bivariate distribution function.

**Author(s)**

Gustavo Soutinho and Luis Meira-Machado

**References**

See Also

IPCdf, KMWdf, LINdf and LMDf.

Examples

data("bladder3")

b3<-multidf(gap1=bladder3$t1, event1=bladder3$d1, 
gap2=bladder3$t2-bladder3$t1, status=bladder4state$d2)

head(b3[[1]])
WCHdf(b3,x=13,y=20)
Index

* datasets

b3, 3
b3size, 3
b3state, 4
b3state2, 5
b4, 5
b4state, 6
bladder3, 8
bladder3state, 9
bladder4, 9
bladder4state, 10
bladder5, 11
bladder5state, 11

IPCWdf, 12, 18, 20, 22, 28

KM, 14
KMW, 15
KMW3df, 16, 21, 26
KMWdf, 13, 17, 20, 22, 25, 28

LDM3df, 16, 18, 19, 21, 26
LDMdf, 13, 18, 19, 22, 25, 28
LIN3df, 16, 19, 20, 26
LINdf, 13, 18, 20, 21, 25, 28
multidf, 22

NWW, 23
par, 25
plot.multidf, 24
WCH3df, 16, 19, 21, 26
WCHdf, 13, 18, 20, 22, 25, 27